Proactive Materials Degradation Assessment
Westinghouse Four-Loop PWR Systems

Compilation of Scoring and Comments by Expert Panel

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Degradation Mechanism Codes

BAC	Boric Acid Corrosion
CREEP	Thermal Creep
CREV	Crevice Corrosion
DEBOND	De-bonding
EC	Erosion Corrosion Including Steam Cutting and Cavitation
FAC	Flow-Assisted Corrosion
FAT	Fatigue
FR	Reduction of Fracture Resistance
GALV	Galvanic Corrosion
GC	General Corrosion
IC	Irradiation Creep
MIC	Microbiologically Induced Corrosion
PIT	Pitting Corrosion
SCC	Stress Corrosion Cracking
SW	Swelling
WEAR	Fretting/Wear

Subgroup **1.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-CL
1-28

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **1.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-CL
1-28

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	susceptibility 3 if wet
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **1.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
2,19

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field and evaluation of strain amplitude/surface roughness. Ongoing concern associated with corrosion fatigue at low potentials (c.f. ANL data)	Very good field experience probably because of original overdesign Only likely to be a problem where present design rules give CUF>0.1approx.Uncertainties in system definition offset by inspection capabilities
5	Low	High	High	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Low	High	High	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
8	Medium	High	High	Good lab data base but uncertainty on accounting for magnitude of environmental effects. Problems in a number of primary circuit dead legs.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1.

Subgroup **1.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
2,19

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	Low	Low	Cold work (grinding, or >30%) may cause IGSCC…lab tests	susceptibility 3 if cold work > 10%
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	Unless damaged or high stresses, the non-HAZ sections of pipe should be of little concern.	

Subgroup
1.3.1

Austenitic piping weld HAZs
Type 304, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
2,9,10,19, 20,21,22,23,25,27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Lab data base is not as extensive as for wrought materials	Very good field experience
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Medium	Medium	Medium	Corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Lab data base is weak compared to wrought materials. Good field experience.	

Subgroup **1.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
2,9,10,19, 20,21,22,23,25,27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue in conjunction with high HAZ strains	Good field experience. Question if cold work may elevate problem in some plants.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Growth will occur, but initiation may be difficult if crevices and surface cold work are minimal.

Subgroup **1.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
2,9,10,19, 20,21,22,23,25,27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Lab data base is not as extensive as for wrought materials	Very good field experience
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Medium	Medium	Medium	Corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Lab data base is weak compared to wrought materials. Good field experience.	

Subgroup
1.3.2

Austenitic piping weld HAZs
Type 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
2,9,10,19, 20,21,22,23,25,27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue in conjunction with high HAZ strains	Good field experience. Question if cold work may elevate problem in some plants.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Growth will occur, but initiation may be difficult if crevices and surface cold work are minimal.

Subgroup **1.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
1,3,4,5,6,7 8,11,12,13,14,15,16,17,18,24,26,28

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 18
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 18, exacerbated by surface cold work
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but dead legs (e.g. parts 12 to 18) might be vulnerable to thermal fatigue
7	Low	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Lab data base is weak compared to wrought materials. Problems in a number of primary circuit dead legs.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 18

Subgroup **1.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
1,3,4,5,6,7 8,11,12,13,14,15,16,17,18,24,26,28

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	High	Well characterized	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lowere after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup **1.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
1,3,4,5,6,7 8,11,12,13,14,15,16,17,18,24,26,28

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	Low	Not observed in plant but may be observed in laboratory depending on combinations of corrosion potential and strain rate	Lack of knowledge as to the margins that exist between plant system conditions and laboratory conditions that will give rise to cracking
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **1.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
1,20,21,22,28

Notes: 1(B&W and CE Plants only),20(B&W and CE Plants only),21(B&W and CE Plants only),22(CE Plants only),28

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where nominal CUF exceeds about 0.1
7	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1.

Subgroup **1.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
1,20,21,22,28

Notes: 1(B&W and CE Plants only),20(B&W and CE Plants only),21(B&W and CE Plants only),22(CE Plants only),28

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Low	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup **1.5** Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
1,20,21,22,28

Notes: 1(B&W and CE Plants only),20(B&W and CE Plants only),21(B&W and CE Plants only),22(CE Plants only),28

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen	Hydrogenated primary water ensuring no dissolved oxygen.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Question as to specific parameters of importance in reactor components and potential significance to be a SCC initiation site in LAS RPV
5	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic weld metals due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization - occurs from outside, perhaps before component is put in service.	Evidence is that this cracking occurs prior to service but not all agree

Subgroup **1.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
9,22,25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Low	Low	Lack of data, but good field experience.	Only likely to be a problem where present design rules give CUF > 0.1 approx.
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Cyclic stresses limited	

Subgroup **1.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
9,22,25

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models. The crotch corner of the angled nozzle (part 22) is potentially the most vulnerable due to high stress.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical)	Known issue. Effective prediction models.
5	Low	Medium	Medium	issue only if more than 20% ferrite	
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lowered after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition. Hydrogen may play a critical role in cracking. Not necessary by hydrogen embrittlement.
8	Low	Medium	Medium	Well characterized	Known issue. Effective prediction models.

Subgroup **1.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
9,22,25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Medium	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA:(spinoda;l decomposition)) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Magnitude of problem unclear but of concern as cast SS age.	Sufficient doubts to initiate testing program in Europe to assess long term risk.

Subgroup **1.7**

Socket welds
Types 304, 308, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
3,5,6

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	High	High	Low	Significant field experience of failures	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Medium	High	Low	Known issue due to design detail and flow induced vibration	FIV can increase susceptibility
6	High	High	Medium	Failures at multiple plants	Depends on flow induced vibration which is associated with design details.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	High	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **1.7**

Socket welds
Types 304, 308, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
3,5,6

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups. The SCC may be accelerated by corrosion fatigue where the ripple effect accelerates SCC.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Medium	High	Low	Semantics problem with definition of SCC and corrosion fatigue which is highlighted with these components	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Low	High	High	Possible if high stresses present	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Medium	High	Medium	Concern, but probably overwhelmed by corrosion fatigue	

Subgroup **1.8**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
10,20,21,23,27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem

Subgroup **1.8**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-CL
10,20,21,23,27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	Medium	Medium	Unless damaged or high stresses, the non-HAZ sections of pipe (presumably no cold work) should be of little concern.	

Subgroup **1.9**

Dissimilar metal welds
Type 308, 309
External Surface

Applies to BNL Part #s with prefix RCS-CL
1,20,21,22,28

Notes: 1(B&W and CE Plants only),20(B&W and CE Plants only),21(B&W and CE Plants only),22(CE Plants only),28

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Specific parameters except Cl not identified.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	--	--	--	Insufficient experience with this cracking mode (i.e. external environment) to make a judgement	
5	Low	High	High	Needs contamination by corrosive species, moisture and high stresses	
6	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	High	High	High	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization - occurs from outside, perhaps before component is put in service.	Evidence is that this cracking occurs prior to service but not all agree

Subgroup **1.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-CL
For Other Westinghouse Plants
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Low	Low	Lack of data, but good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Cyclic stresses limited	

Subgroup **1.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-CL
For Other Westinghouse Plants
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical)	Known issue. Effective prediction models.
5	--	Low	Low		
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium	Well characterized	Known issue. Effective prediction models.

Subgroup **1.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-CL
For Other Westinghouse Plants
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
5	Low	High	High	Possible if high stresses present	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. as cast SS age	Sufficient doubts to initiate testing program in Europe to assess long term risk.

Subgroup **1.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-CL
For CE and B&W Plants
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Potentially very vulnerable to nearby leaks	Leaks from valves, flanged joints etc
2	Low	Medium	Medium	Only in the event of cladding penetration	
3	0	Low	Low	I see no basis for singling out BAC here since we did not for the austenitic piping where the solution is dilute and average water chemistry is not aggressive	No comment
4	Low	High	Low	Unlikely to be a problem due to lack of oxygen and an obvious mechanism to concentrate the boric acid. Low knowledge score underlies our uncertainty in this statement following on from Davis Besse incident	
5	Low	High	High	needs means to concentrate boric acid; e.g. leakage to outside environment	
6	Medium	High	Medium	Well-known phenomenon. Requires a boric acid leak that falls onto the outside (carbon steel) surface of the clad pipe	Requires a leak that is sufficient to keep the outer surface wet.
7	Medium	High	Medium	After clad failure, Boric acid corrosion of carbon steels can take place.	Stagnant location if there are the most vulnerable parts when exposed to high DO condition after the crack in clad.
8	Low	Medium	Medium		

Subgroup
1.11

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-CL
For CE and B&W Plants
Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	High	Fabrication issue. Good experience.	
3	Low	Medium	Medium	Difference in coefficient of expansion. Not aware of such thermal cyclic data except for good field performance	
4	Low	High	High	Phenomenum observed relativel early in LWR history, which has been resolved via tighter fabrication specifications	
5	Low	High	High	unlikely except at sites of poor adhesion (fabrication) or where the cladding has been damaged/penetrated by mechanical action.	
6	Low	High	High	Well-understood fabrication issue	Details of the cladding process
7	Low	High	High	Theoretical concern and unlikely in the plants	Bond strength and a formation of embrittled phase.
8	Low	High	High		

Subgroup **1.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-CL
For CE and B&W Plants
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Excellent operating experience for more than 30 years	Absence of oxygen in primary water even where excessive dilution of the cladding may present a potentially vulnerable microstructure
2	Low	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	High	High	needs high cyclic stresses plus high residual stresses; plus cladding penetration	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but dead legs might be vulnerable to thermal fatigue
7	Low	Medium	Medium	Corrosion fatigue susceptibility after low temperature dynamic strain aging(LTDSA) is not clear.(better?)	Surface finish a known influencing factor
8	Low	Medium	Medium		

Subgroup **1.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-CL
For CE and B&W Plants
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience due to excellent SCC resistance of stainless steel cladding.	Not anticipated to be a long term problem due to negligible dissolved oxygen. Excessive dilution of stainless clad may give potentially susceptible microstructure
2	Low	Medium	Medium	Good field experience to date.	
3	Low	High	Medium	Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite.	Longer times, surface dings and dents.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization. Scoring relates to SCC of the cladding. Cracks, if they occur, very unlikely to propagate into the carbon steel	
5	Low	High	High	penetration of cladding plus contamination and high stresses	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature dynamic strain aging(LTDSA) is not clear.	LTDSA
8	Low	Medium	Medium		

Subgroup **2.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-XL
1-18

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **2.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-XL
1-18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **2.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
7,11

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in the field	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Uncertainty in accounting for magnitude of total environmental effects	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	High	High	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in the field	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	High	High	Good lab data base but doubts on magnitude of environmental effects in the field	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **2.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
7,11

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	Medium	Unless damaged or high stresses, the non-HAZ sections of pipe (presumably not cold worked) should be of little concern.	

Subgroup **2.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
3,5,7,9,11,15,17

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Lab data base is not as extensive as for wrought materials; therefore lower knowledge score; concern with plastic constraint/high strain issues.	Very good field experience
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far. corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Very good field experience

Subgroup **2.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
3,5,7,9,11,15,17

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Good field experience. Question if cold work may elevate problem in some plants
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Very good field experience and not anticipated to be a long term problem

Subgroup **2.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
3,5,7,9,11,15,17

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Lab data base is not as extensive as for wrought materials; therefore lower knowledge score; concern with plastic constraint/high strain issues.	Very good field experience
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far. corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Very good field experience

Subgroup **2.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
3,5,7,9,11,15,17

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Good field experience. Question if cold work may elevate problem in some plants
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Good field experience - no known cracking due to SCC, but the lab data is troubling	Very good field experience and not anticipated to be a long term problem

Subgroup **2.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
1,2,4,6,8,10,12,13,14,16,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 14
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	Medium	Low	Doubt lab data base is as good as for wrought materials	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 14
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but dead legs (e.g. parts 12 to 14) might be vulnerable to thermal fatigue
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 14
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 14

Subgroup **2.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
1,2,4,6,8,10,12,13,14,16,18

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	High	Well characterized	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup **2.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
1,2,4,6,8,10,12,13,14,16,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	Low	Not observed in plant but may be observed in laboratory depending on combinations of corrosion potential and strain rate	Lack of knowledge as to the margins that exist between plant system conditions and laboratory conditions that will give rise to cracking
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **2.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
1,2,15,18

Notes: 1,2,15(B&W and CE Plants only),18(B&W and CE Plants only)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where nominal CUF exceeds about 0.1
7	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **2.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
1,2,15,18

Notes: 1,2,15(B&W and CE Plants only),18(B&W and CE Plants only)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Low	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup **2.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
1,2,15,18

Notes: 1,2,15(B&W and CE Plants only),18(B&W and CE Plants only)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen	Hydrogenated primary water ensuring no dissolved oxygen.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Question as to specific parameters of importance in reactor components and potential significance to be a SCC initiation site in LAS SG Shell and RPV
5	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic weld metals due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down. Effects of LT aging is not clear.
8	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization - occurs from outside, perhaps before component is put in service.	Evidence is that this cracking occurs prior to service but not all agree

Subgroup **2.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
5,9,17

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Low	Low	Lab data limited. Good field experience.	
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Cyclic stresses limited	

Subgroup **2.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
5,9,17

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical)	Known issue. Effective prediction models.
5	--	Low	Low		
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition. Hydrogen may play a critical role in cracking. Not necessary by hydrogen embrittlement.
8	Low	Medium	Medium	Well characterized	Known issue. Effective prediction models.

Subgroup **2.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
5,9,17

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA:spinodal decomposition) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with aging	Sufficient doubts to initiate testing program in Europe to assess long term risk.

Subgroup **2.7**

Socket welds
Types 304, 308, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
12,14

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	High	High	Low	Significant field experience of failures	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Medium	High	Low	Known issue due to design detail and flow induced vibration	
6	High	High	Medium	Failures at multiple plants	Depends on flow induced vibration which is associated with design details.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	High	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **2.7**

Socket welds
Types 304, 308, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
12,14

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups. The SCC may be accelerated by corrosion fatigue where the ripple effect accelerates SCC.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Medium	High	Low	Semantics problem with definition of SCC and corrosion fatigue which is highlighted with these components	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Medium	High	Medium	Concern, but probably overwhelmed by corrosion fatigue	

Subgroup **2.8**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
3,15

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. part 15
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. part 15
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. part 15
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem

Subgroup **2.8**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-XL
3,15
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	Medium	Medium	Unless damaged or high stresses, the non-HAZ sections of pipe should be of little concern.	

Subgroup **2.9**

Dissimilar metal welds
Type 308, 309
External surface

Applies to BNL Part #s with prefix RCS-XL
1,2,15,18

Notes: 1,2,15(B&W and CE Plants only),18(B&W and CE Plants only)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Specific parameters except Cl not identified.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	--	--	--	Insufficient experience with this cracking mode (i.e. external environment) to make a judgement	
5	Low	High	High	needs moisture and corrosive species concentration (e.g. under deposits) plus high stresses	
6	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	High	High	High	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization - occurs from outside, perhaps before component is put in service.	Evidence is that this cracking occurs prior to service but not all agree

Subgroup **2.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-XL
For other Westinghouse Plants
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Cyclic stresses limited	

Subgroup **2.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-XL
For other Westinghouse Plants
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical)	Known issue. Effective prediction models.
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium	Well characterized	Known issue. Effective prediction models.

Subgroup **2.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
556 to 559°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-XL
For other Westinghouse Plants
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with thermal aging	Sufficient doubts to initiate testing program in Europe to assess long term risk.

Subgroup **2.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-XL
For CE and B&W Plants
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Potentially very vulnerable to nearby leaks	Leaks from valves, flanged joints etc
2	Low	Medium	Medium	Only in the event of cladding penetration	
3	0	Low	Low	I see no basis for singling out BAC here since we did not for the austenitic piping where the solution is dilute and average water chemistry is not aggressive	No comment
4	Low	High	Low	Unlikely to be a problem due to lack of oxygen and an obvious mechanism to concentrate the boric acid. Low knowledge score underlies our uncertainty in this statement following on from Davis Besse incident	
5	Low	High	High	needs means to concentrate boric acid; e.g. leakage to outside environment	
6	Medium	High	High	Well-known phenomenon. Requires a boric acid leak that falls onto the outside (carbon steel) surface of the clad pipe	Requires a leak that is sufficient to keep the outer surface wet.
7	Low	High	High	After clad failure, Boric acid corrosion of carbon steels can take place.	Stagnant location if there are the most vulnerable parts when exposed to high DO condition after the crack in clad.
8	Low	Medium	Medium		

Subgroup **2.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-XL
For CE and B&W Plants
Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	High	Fabrication issue. Good experience.	
3	Low	Medium	Medium	Difference in coefficient of expansion. Not aware of such thermal cyclic data except for good field performance	
4	Low	High	High	Phenomenum observed relativel early in LWR history, which has been resolved via tighter fabrication specifications	
5	Low	High	High	unlikely except at sites of poor adhesion (fabrication) or where the cladding has been damaged/penetrated by mechanical action.	
6	Low	High	High	Well-understood fabrication issue	Details of the cladding process
7	Low	High	High	Theoretical concern and unlikely in the plants	Bond strength and a formation of embrittled phase.
8	Low	High	High		

Subgroup **2.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-XL
For CE and B&W Plants
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Excellent operating experience for more than 30 years	Absence of oxygen in primary water even where excessive dilution of the cladding may present a potentially vulnerable microstructure
2	Low	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	High	High	needs high cyclic stresses plus high residual stresses; plus cladding penetration	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but dead legs might be vulnerable to thermal fatigue
7	Low	Medium	Medium	Corrosion fatigue susceptibility after low temperature dynamic strain aging(LTDSA) is not clear.(better?)	Surface finish a known influencing factor
8	Low	Medium	Medium		

Subgroup **2.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 556 to 559°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-XL
For CE and B&W Plants
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience due to excellent SCC resistance of stainless steel cladding.	Not anticipated to be a long term problem due to negligible dissolved oxygen. Excessive dilution of stainless clad may give potentially susceptible microstructure
2	Low	Medium	Medium	Good field experience to date.	
3	Low	High	Medium	Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite.	Longer times, surface dings and dents.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization. Scoring relates to SCC of the cladding. Cracks, if they occur, very unlikely to propagate into the carbon steel	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here and also needs cladding penetration	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature dynamic strain aging(LTDSA) is not clear.	LTDSA
8	Low	Medium	Medium		

Subgroup **3.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-HL
1-22

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **3.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-HL
1-22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **3.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
4

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in the field.	Only likely to be a problem where present nominal CUF>0.1approx. Additional issue of thermal striping from low leakage cores applies
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects. 2 scoring on susceptibility reflects higher temp.	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Very good field experience but doubts on environmental effects from laboratory data. Thermal cycling due to striping from low leakage cores a concern.	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in the field.	Only likely to be a problem where present nominal CUF>0.1approx. Additional issue of thermal striping from low leakage cores applies
8	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Very good field experience. Only likely to be a problem where present nominal FUF>0.1approx. Additional issue of thermal striping from low leakage cores applies

Subgroup **3.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
4

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	Medium	Unless damaged or high stresses, the non-HAZ sections of pipe should be of little concern.	

Subgroup **3.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
2,4,8,11,10,17,18,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1" Susceptibility rating increased due to higher temp.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Medium	Medium	Medium	Very good field experience to date but corrosion fatigue of austenitic materials is a known issue.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Very good field experience but concern for thermal striping from low leakage cores

Subgroup **3.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
2,4,8,11,10,17,18,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs.	Not anticipated to be a long term problem due to negligible dissolved oxygen
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Not anticipated to be a long term problem due to negligible dissolved oxygen
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Very good field experience and not anticipated to be a long term problem.

Subgroup **3.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
2,4,8,11,10,17,18,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1" Susceptibility rating increased due to higher temp.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Medium	Medium	Medium	Very good field experience to date but corrosion fatigue of austenitic materials is a known issue.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Very good field experience but concern for thermal striping from low leakage cores

Subgroup
3.3.2

Austenitic piping weld HAZs
Type 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
2,4,8,11,10,17,18,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs.	Not anticipated to be a long term problem due to negligible dissolved oxygen
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Not anticipated to be a long term problem due to negligible dissolved oxygen
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Very good field experience and not anticipated to be a long term problem.

Subgroup **3.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
1,3,5,6,7,9,12,13,14,15,16,19,21,22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 5 to 7
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Low	Doubt lab data base is as good as for wrought materials. Elevated susceptibility to 2 because of increased temp	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 5 to 7
5	Medium	Medium	Medium	Very good field experience but doubts on environmental effects from laboratory data. Thermal cycling due to striping from low leakage cores a concern.	
6	Medium	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however.)	Additional issue of thermal striping from low leakage cores applies. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 5 to 7
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Very good field experience but concern for thermal striping from low leakage cores

Subgroup **3.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
1,3,5,6,7,9,12,13,14,15,16,19,21,22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	High	Well characterized	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup **3.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
1,3,5,6,7,9,12,13,14,15,16,19,21,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Not observed in plant but may be observed in laboratory depending on combinations of corrosion potential and strain rate. Susceptibility score increased to 2 because of temperature	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **3.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
1,6,7,8,17,21,22

Notes: 1,6,7,8,17 B&W and CE Plants

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx + low leakage core issue.
2	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Only likely to be a problem where present nominal CUF>0.1approx + low leakage core issue.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects + striping	
6	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where nominal CUF exceeds about 0.1
7	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx + low leakage core issue.

Subgroup **3.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
1,6,7,8,17,21,22

Notes: 1,6,7,8,17 B&W and CE Plants

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Low	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup **3.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
1,6,7,8,17,21,22

Notes: 1,6,7,8,17 B&W and CE Plants

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen	Hydrogenated primary water ensuring no dissolved oxygen.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Question as to specific parameters of importance in reactor components and potential significance to be a SCC initiation site in LAS SG Shell and RPV
5	Medium	High	Low	Known issue in dilution zone with welds to low alloy steel - sensitization	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic weld metals due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.

Subgroup **3.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
10,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Low	Low	Lab data limited. Good field experience.	
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Cyclic stresses limited	

Subgroup **3.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
10,18

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical)	Known issue. Effective prediction models.
5	--	Low	Low	Known issue if delta ferrite >20%	
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition. Hydrogen may play a critical role in cracking. Not necessary by hydrogen embrittlement.
8	Low	Medium	Medium		Known issue. Effective prediction models.

Subgroup **3.6**

Cast stainless steel components
CF8, CF8M, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
10,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA:spinodal decomposition) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Inadequate data, but concern after aging.	Sufficient doubts to initiate testing program in Europe to assess long term risk

Subgroup **3.7**

Socket welds
Types 304, 308, 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
13,15,16

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	High	High	Low	Significant field experience of failures	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Medium	High	Low	Known issue due to design detail a flow induced vibration	
6	High	High	Medium	Failures at multiple plants	Depends on flow induced vibration which is associated with design details.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	High	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **3.7**

Socket welds
Types 304, 308, 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
13,15,16

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups. The SCC may be accelerated by corrosion fatigue where the ripple effect accelerates SCC.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Medium	High	Low	Semantics problem with definition of SCC and corrosion fatigue which is highlighted with these components	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Medium	High	Medium	Concern, but probably overwhelmed by corrosion fatigue	

Subgroup **3.8**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
2,8,11,17,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor + low leakage core issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor + low leakage core issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects. Thermal cycling due to striping from low leakage cores a concern.	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. part 15
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor + low leakage core issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17

Subgroup **3.8**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
610 to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-HL
2,8,11,17,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	Medium	Medium	Unless damaged or high stresses, the non-HAZ sections of pipe should be of little concern.	

Subgroup **3.9**

Dissimilar metal welds
Type 308, 309
External surface

Applies to BNL Part #s with prefix RCS-HL
1,6,7,8,17,21,22

Notes: 1,6,7,8,17 B&W and CE plants

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	--	--	--	Insufficient experience with this cracking mode (i.e. external environment) to make a judgement	
5	Low	High	High	needs moisture and corrosive species concentration (e.g. under deposits) plus high stresses and sensitization	
6	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	High	High	High	External cracking a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization - occurs from outside, perhaps before component is put in service.	Evidence is that this cracking occurs prior to service but not all agree

Subgroup **3.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
610 to 620°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-HL
For other Westinghouse Plants
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Low	Low	Lab data limited. Good field experience.	
3	Low	Medium	Medium	May be affected by variations in metallurgy and discontinuities in casting	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Medium	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far. Increase in Susc. Score to 2 to account for temp.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Cyclic stresses limited	

Subgroup **3.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
610 to 620°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-HL
For other Westinghouse Plants
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	The aging of cast stainless steels produces uncertainties but the fracture resistance is lowered. It is not clear how this issue is a problem for longer times. No sense of statistical distribution of fracture resistance with metallurgical variables	Most likely incided when defects are present. Possible pitting due to metallurgical defects.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical)	Known issue. Effective prediction models.
5	--	Low	Low		
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium	Well characterized	Known issue. Effective prediction models.

Subgroup **3.10**

Cast stainless steel piping
CF8, CF8M, PWR primary water
610 to 620°F, 2250 psia
For other Westinghouse plants

Applies to BNL Part #s with prefix RCS-HL
For other Westinghouse Plants
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	May be affected by variations in metallurgy and discontinuities in casting	Not clear what initiates SCC in cast stainless steels
4	Medium	Low	Low	A theoretical concern at present. Increase in Susc. Score to 2 to account for temp.	Sufficient doubts to initiate testing program in Europe to assess long term risk.
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with thermal aging	Sufficient doubts to initiate testing program in Europe to assess long term risk.

Subgroup **3.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 610 to 620°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-HL
For CE and B&W Plants
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Potentially very vulnerable to nearby leaks	Leaks from valves, flanged joints etc
2	Low	Medium	Medium	Only in the event of cladding penetration	
3	0	Low	Low	I see no basis for singling out BAC here since we did not for the austenitic piping where the solution is dilute and average water chemistry is not aggressive	No comment
4	Low	High	Low	Unlikely to be a problem due to lack of oxygen and an obvious mechanism to concentrate the boric acid. Low knowledge score underlies our uncertainty in this statement following on from Davis Besse incident	
5	Low	High	High	needs means to concentrate boric acid; e.g. leakage to outside environment	
6	Medium	High	High	Well-known phenomenon. Requires a boric acid leak that falls onto the outside (carbon steel) surface of the clad pipe	Requires a leak that is sufficient to keep the outer surface wet.
7	Low	High	High	After clad failure, Boric acid corrosion of carbon steels can take place.	Stagnant location if there are the most vulnerable parts when exposed to high DO condition after the crack in clad.
8	Low	Medium	Medium		

Subgroup **3.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 610 to 620°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-HL
For CE and B&W Plants
Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	High	Fabrication issue. Good experience.	
3	Low	Medium	Medium	Difference in coefficient of expansion. Not aware of such thermal cyclic data except for good field performance	
4	Low	High	High	Phenomenum observed relativel early in LWR history, which has been resolved via tighter fabrication specifications. Should be effective even at higher temperatures	
5	Low	High	High	unlikely except at sites of poor adhesion (fabrication) or where the cladding has been damaged/penetrated by mechanical action.	
6	Low	High	High	Well-understood fabrication issue	Details of the cladding process
7	Low	High	High	Theoretical concern and unlikely in the plants	Bond strength and a formation of embrittled phase.
8	Low	High	High		

Subgroup **3.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 610 to 620°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-HL
For CE and B&W Plants
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Excellent operating experience for more than 30 years	Absence of oxygen in primary water even where excessive dilution of the cladding may present a potentially vulnerable microstructure
2	Low	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
5	Low	High	High	needs high cyclic stresses plus high residual stresses; plus cladding penetration	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but dead legs might be vulnerable to thermal fatigue
7	Low	Medium	Medium	Corrosion fatigue susceptibility after low temperature dynamic strain aging(LTDSA) is not clear.(better?)	Surface finish a known influencing factor
8	Low	Medium	Medium		

Subgroup **3.11**

Clad ferritic steel piping
stainless steel clad carbon steel
PWR primary water, 610 to 620°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix RCS-HL
For CE and B&W Plants
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience due to excellent SCC resistance of stainless steel cladding.	Not anticipated to be a long term problem due to negligible dissolved oxygen. Excessive dilution of stainless clad may give potentially susceptible microstructure
2	Low	Medium	Medium	Good field experience to date.	
3	Low	High	Medium	Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite.	Longer times, surface dings and dents.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization. Scoring relates to SCC of the cladding. Cracks, if they occur, very unlikely to propagate into the carbon steel	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination; unlikely here and also needs cladding penetration	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature dynamic strain aging(LTDSA) is not clear.	LTDSA
8	Low	Medium	Medium		

Subgroup **4.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-PZR
10,17,18,19,20,21,22,32,33,39,41

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **4.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-PZR
10,17,18,19,20,21,22,32,33,39,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **4.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2
PWR primary water, Up to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,23,24,25,30,34,35,36,37,40,42,43

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Potentially very vulnerable to leaks of primary water.	Leaks from nozzle welds, heater sleeves etc
2	--	--	--	Not an issue from inside	
3	Low	High	High	The boric acid corrosion is no issue if there are not SCC events at welds or cracking prone alloys. However, BAC is rapid when the boric acid is hot and concentrated and at high velocities.	Depends of SCC at penetrations.
4	Low	Medium	Low	No observations to date. However may be possible under leakage situations where O2 supply assured	Highly dependent on specifics of penetration designs.
5	Medium	High	High	an issue if boric acid can concentrate on a heated surface, or in vicinity of a leak	
6	Low	High	High	Potential for external boric acid corrosion if leakage of primary coolant occurs	Significant damage is only possible if significant leakage occurs and is ignored by plant staff
7	Low	High	High	Always potential problem after leakage.	Leak detection
8	Medium	Medium	Medium		

Subgroup **4.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2
PWR primary water, Up to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,23,24,25,30,34,35,36,37,40,42,43

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Not normally exposed to PWR primary water but can be after repairs to heater penetrations (Part 26)	Not anticipated to be a problem due to negligible dissolved oxygen except possibly during shutdown.
2	Low	High	High	Susceptible material	Will be very individual, depends more on manufacturing details than design.
3	Low	Medium	Medium	Since the steel is not adjacent to water, this is not likely unless there is a breach of the cladding or a breach of a penetration. The action of a crevice would contribute to pitting or local penetrations that might affect the initiation of either or both SCC and corrosion fatigue.	Only if debond on the inside or moist on the outside at a crevice location.
4	Low	High	Low	No observations to date. However may be possible under leakage situations where O2 supply assured to give required electrochemical conditions	Highly dependent on specifics of penetration designs.
5	Low	High	High	needs deposits or mechanical crevices; unlikely here	
6	Low	Medium	Medium	Generally good experience to date but some potential for damage exists	Not expected to be a significant damage form under plant service conditions
7	Low	High	High	Need to quantify how crevice formation and crevice solution chemistry can be developed.	
8	Low	High	High		

Subgroup **4.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2
PWR primary water, Up to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,23,24,25,30,34,35,36,37,40,42,43

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience	Theoretical risk of corrosion fatigue/SCC if cladding penetrated (excluding no.25).
2	Low	High	High	Very good field experience	Theoretical risk of corrosion fatigue/SCC if cladding penetrated (excluding no.25).
3	Low	High	High	Many pressurizers operating and no failures of vessel wall. Also, wall is not exposed to inside water unless break of clad or some defect (discussed in Section 4.3). Some SCC occurs in alloy steel at temperatures as could occur on outside surface. Probably not likely.	Possible water and impurity deposits might occur on outside although not likely.
4	Low	High	High	Very good field experience	Theoretical risk of corrosion fatigue if cladding penetrated (excluding no.25).
5	Low	High	High	Very good field experience	
6	Low	High	High	Very good field experience	Theoretical risk of corrosion fatigue/SCC if cladding penetrated (excluding no.25).
7	Low	High	High	Very good field experience	Theoretical risk of corrosion fatigue/SCC if cladding penetrated (excluding no.25).
8	Medium	High	High	Very good field experience	Theoretical risk of corrosion fatigue/SCC if cladding penetrated (excluding no.25).

Subgroup **4.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2
PWR primary water, Up to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,23,24,25,30,34,35,36,37,40,42,43

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No irradiation damage	No irradiation damage
2	Low	High	High	Well characterized	Known issue. Effective prediction models.
3	Low	High	High	Fracture resistance at operating temperature is good for these steels.	Possible occurrence of defect from any special outside machining or welding.
4	Low	Medium	Low	Little theoretical reason why this should be a problem since no irradiation and other obvious embrittling mechanism . Confidence score of 2 mirroring consequence if judgement is wrong	Underlying issue of possible deleterious effect of dynamic strain rates on fracture toughness, when measured in the relevant environment
5	Low	Low	Medium	Theoretical risk of corrosion fatigue/SCC if cladding penetrated	
6	Low	Medium	Medium	No irradiation damage. Not aware of any other proven FR mechanism for these materials that would result in significant degradation under these service conditions	No significant degradation expected in service in a PWR pressurizer
7	Low	Medium	Medium	Environmental effects can lower the FR curves. Many experimental data have been obtained by CT and 3pt. Bending	A part of SCC phenomena
8	Medium	High	Medium	No irradiation damage	No irradiation damage

Subgroup **4.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2
PWR primary water, Up to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,23,24,25,30,34,35,36,37,40,42,43

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience due to excellent SCC resistance of stainless steel cladding.	Not anticipated to be a long term problem due to effective isolation from the aqueous environment.
2	Low	High	High	Well characterized and only an issue under very specific loading conditions. Very good field experience	
3	Low	Medium	Medium	The PV steels are prone to SCC but less at low potentials. The inside surface of the vessel is clad so this is nominally not a problem here. Could occur from outside from a moist location where moisture is somehow sequestered.	Oxygenated conditions
4	Low	High	Medium	Highly unlikely in these PWR environments unless there is an oxidizing species present that would counteract the H2 reducing effect	
5	Low	High	High	needs high stresses and corrosive environment	
6	Low	High	High	Generally good experience to date but some potential for damage exists	Not expected to be a significant damage form under plant service conditions
7	Low	High	High	Low alloy steels can show EAC under some contaminated water chemistry but not in typical PWR environment but need to examine the effects of LTA or LTDSA	SCC susceptibility after low temperature aging(LTDSA) is not clear. Hardening can increase SCC susceptibility
8	Low	Medium	Medium	Some concern for 182 weld pads and high K when crack hits shell	

Subgroup **4.3**

Stainless steel cladding
Types 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
All pressure boundary internal surfaces
Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fabrication issue for which the precursors are now well understood and avoided. No obvious mechanism for growth except fatigue.	Fabrication issue
2	Low	Low	Low	Good field experience, must be in combination with cracking of cladding to be a problem	
3	Low	Medium	Medium	Debonding would result from many cycles of temperature change over long times and would result from the large difference in thermal expansivity of the stainless steel and alloy steel.	Possibly at long times after many cycles.
4	Medium	Medium	Medium	Possible , but would likely be associated with fabrication and would have occurred early in life.	
5	Low	High	High	has been seen but not common	
6	Low	Medium	Medium	Has occurred occasionally in the field	Susceptibility depends on the details of the cladding process
7	Low	High	High	Good field experience	
8	Medium	Medium	Medium	Some isolated debonds almost certainly exist - unclear whether this would spall cladding or cause other problems	

Subgroup **4.3**

Stainless steel cladding
Types 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
All pressure boundary internal surfaces
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good field experience	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld clad uncertain.
2	Low	Low	Low	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	High	Good field experience	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld clad uncertain.
5	Low	High	High	Good field experience	
6	Low	Medium	Medium	Good field experience but corrosion fatigue of austenitic material is a known issue	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld clad uncertain.
7	Low	Medium	Medium	Good field experience	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld clad uncertain.
8	Low	Medium	Medium	Good field experience	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld clad uncertain.

Subgroup **4.3**

Stainless steel cladding
Types 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
All pressure boundary internal surfaces
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No evidence that it occurs and not expected from first principles. Slag inclusions may dissolve away but no propagation afterwards.	Not anticipated to be a problem due to negligible dissolved oxygen.
2	Low	High	High	Only a problem if poor chemistry control	
3	Low	Medium	Medium	Good field performance. Some possibility if oxygen access during shutdown.	Shutdowns with impurities
4	Low	High	High	Unlikely unless oxidizing conditions and anionic impurity conjointly present. Not likely with current water chemistry guidelines	
5	Low	High	High	needs corrosive environment; unlikely here	
6	Low	Medium	Medium	Hasn't been a major concern to date	More likely to be a significant issue if the primary chemistry gets seriously out-of-whack
7	Low	High	High	Good field experience	
8	Low	Medium	Medium		

Subgroup **4.3**

Stainless steel cladding
Types 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
All pressure boundary internal surfaces
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good field experience. Underclad cracks a fabrication issue.	No problems anticipated in normal PWR primary water with negligible oxygen. Excessive dilution of stainless clad may give potentially susceptible microstructure
2	Low	Medium	Medium	Good field experience.	
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Medium	Medium	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Question as to specific parameters of importance in reactor components and potential significance to be a SCC initiation site in pressurizer shell
5	Low	High	High	Good field experience	
6	Low	Medium	Medium	Good field experience. Underclad cracks a fabrication issue.	Cracking is unlikely at the low ECPs typical of PWR operation
7	Low	High	High	Good field experience. Underclad cracks a fabrication issue.	No problems anticipated in normal PWR primary water with negligible oxygen.
8	Low	High	High	Good field experience. Underclad cracks a fabrication issue.	No problems anticipated in normal PWR primary water with negligible oxygen.

Subgroup **4.4**

Wrought stainless steel (Internal)
Types 304, 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27,28,29,31,38

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in service	Thermal sleeves potentially vulnerable where present nominal CUF>0.1approx. Note that the heater to sleeve attachment welds, part 27, is a known fatigue sensitive zone.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Low	Good lab data base but doubts on magnitude of environmental effects	Thermal sleeves and other internals potentially vulnerable
5	Low	Medium	Low	Thermal sleeves and heater supports potentially vulnerable	
6	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem if design CUF exceeds about 0.1. Thermal sleeves could be particularly susceptible
7	Medium	Medium	Low	Significant reduction of fatigue life in 300 SS at low frequency corrosion fatigue(Japanese EFT results)	Thermal sleeves potentially vulnerable where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in service	Thermal sleeves potentially vulnerable where present nominal CUF>0.1approx.

Subgroup **4.4**

Wrought stainless steel (Internal)
Types 304, 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27,28,29,31,38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	Medium	Medium	Field performance good. Experiments at INSS show such SCC	
4	Low	High	High	Unlikely for stainless steels, due to low corrosion potential, and lack of obvious stress component	
5	Low	High	High	Unlikely unless heavily cold worked and exposed to oxidizing conditions; possible at shutdowns?	
6	Low	High	High	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	High	High	Hardeening may increase SCC susceptibility in these alloys in PWR	Hardness.
8	Low	High	High		

Subgroup **4.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
17,18,19,20,21,22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx. Note, however, that the nozzles and their attachment welds at the top of the pressurizer, parts 17,18,19,20,21,22, are known fatigue sensitive zones.
2	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem if design CUF exceeds about 0.1. Field experience has been good to date
7	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **4.5**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
17,18,19,20,21,22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld deposits susceptible to thermal aging but less so than in cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Martensite phase at low alloy steel interface due to excessive weld heat input can and has cracked - fabrication issue	Known issue. Effective prediction models for austeno-ferritic weld deposits.
2	--	--	--	Do not consider this a problem	
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Low	Medium	Medium	Dilution zone with low alloy steel and two phase alloy may cause reduction of fracture toughness due to spinodal decomposition and additional environmental effects. Low temperature aging (LTA) is not clear in reduction in fracture resistance..	
8	Low	High	Low	Aging of ferrite containing weld metal may lead to increased SCC and reduced toughness.	

Subgroup
4.5

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
17,18,19,20,21,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen	Hydrogenated primary water ensuring no dissolved oxygen.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Question as to specific parameters of importance in reactor components and potential significance to be a SCC initiation site in LAS pressurizer shell
5	Medium	High	Low	Known issue in dilution zone with welds to low alloy steel - sensitization	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic weld metals due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.

Subgroup **4.6**

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
10,17,18,19,20,21,22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx. Note, however, that the nozzles and their attachment welds at the top of the pressurizer, parts 17,18,19,20,21,22, are known fatigue sensitive zones.
2	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
3	Medium	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **4.6**

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
10,17,18,19,20,21,22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fully austenitic - toughness not an issue	
2	Low	High	High	Well characterized	Known issue. Effective prediction models.
3	Medium	Medium	Medium	The existing Mills data show that the main loss of fracture resistance occurs at low temperate and that the 690 type is more prone to lose toughness than the 600. However, these patterns are not yet well defined. Nonetheless, careful attention should be given to operating conditions where the Alloy 600 base is exposed to lwer temperatures and possibly some concern at higher temperatures	Lower temperatures more likely to produce lower fracture resistance for 600 base although greater degradation seems to occur in the 690 base
4	Medium	High	Low	There is a potential LTCP problem with these materials and also for replacement 52/152	The specific danger is dependent on the T/t transients and whether these can occur during normal or severe accident operation. This necessary knowledge does not currently exist.
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals	It's not clear if the conditions required for LTCP in lab tests are met in PWR service. The likelihood appears greatest during cooldown.
7	Medium	Medium	Medium	FR can be lowered by LTC in connection with hydrogen effects.	SCC affects FR curves but not critical crack growth. LTC I caused by SCC, which is a kind of subcritical crack growth. No unstable fracture will take place at the K or J at onset of crack growth.
8	Medium	Medium	Medium		

Subgroup **4.6**

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
10,17,18,19,20,21,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Generic issue for alloys 82/182.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.
2	High	High	Medium	Generic issue for alloys 82/182.	Insufficient understanding of problem, and need for development of inspection and prediction tools
3	High	High	High	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	High	High	Low	IGSCC in PWR primary water a generic issue for alloys 600/82/182 only. Lower value for "knowledge" reflects life management concerns following VC Summer hot leg and VHP incidents. We have poor predictive capabilities for e.g. composition effects and little assurance that mitigation actions associated with 690/152/52 will be fully effective. "good" experience with replacement SG tubes not necessarily relevant. Poor specs for welding procedures for these high Cr alloys.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.
5	Medium	High	Low	Known issue in dilution zone with welds to low alloy steel - sensitization	
6	High	High	Medium	Generic issue for alloys 82/182.	Long and very variable crack initiation times and unpredictable crack growth rates. No fully qualified chemistry mitigation actions available
7	High	High	Medium	Generic issue for alloys 82/182.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water. Leak was found in Ohi-3 VHP after 4(?) EDY
8	High	High	Medium	Generic issue for alloys 82/182.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.

Subgroup **4.7**

Forged austenitic nozzles
Alloy 600, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
26,32,33,39,41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor. Only likely to be a problem where present nominal CUF>0.1approx.
2	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem
5	Medium	Medium	Medium	Surface finish and cold work a known problem	
6	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem
8	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor

Subgroup **4.7**

Forged austenitic nozzles
Alloy 600, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
26,32,33,39,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Known vulnerability for alloy 600 only (not stainless steels).	Forged alloy 600 IGSCC a known problem (for other plants)
2	High	High	Medium	Known vulnerability	
3	High	High	Medium	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	High	High	Medium	Known vulnerability for alloy 600 only.	Forged alloy 600 SCC a known problem (for other plants)
5	High	High	Medium	Forged alloy 600 SCC a known problem (other designs)	
6	High	High	Medium	Known vulnerability for alloy 600.	Forged alloy 600 IGSCC is a known (but unpredictable) problem. No proven chemistry mitigation approach is available
7	High	High	Medium	Known vulnerability for alloy 600 only.	Forged alloy 600 IGSCC a known problem (for other plants)
8	High	High	Medium	Known vulnerability for alloy 600 only.	Forged alloy 600 IGSCC a known problem (for other plants)

Subgroup **4.8**

Heater cladding/attachement weld
Type 316, cold worked, Type 308
PWR primary water, >653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where present nominal CUF>0.1approx. Note that the heater to sleeve attachment welds, part 27, is a known fatigue sensitive zone.
2	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Medium	The stainless steel weld material should not sustain significant corrosion fatigue in deaerated conditions although the INSS work as well as others shows that SCC occurs. Probably cyclic stressing would accelerate the SCC.	Cyclic thermal stresses also with abusive surface finishes
4	Low	Medium	Low	Possible corrosion fatigue; question completeness of data base for effect of cold work on welds	What is exactness of CUF calculations?
5	Low	Medium	Low	Possible corrosion fatigue	
6	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup
4.8

Heater cladding/attachement weld
Type 316, cold worked, Type 308
PWR primary water, >653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Low	Known issue for heavily cold worked stainless steels (therefore not at the attachment weld).	Effect of LiOH concentration in crevices by boiling especially at end of fuel cycle and during cycle stretch-out is a concern. Attachment weld not subject to thermal flux.
2	Medium	Medium	Low	Known issue for heavily cold worked stainless steels. Dependent on welding procedures	Effect of LiOH concentration in crevices by boiling especially at end of fuel cycle and during cycle stretch-out is a concern.
3	Low	Medium	Medium	The stainless steel weld material should not sustain significant corrosion fatigue in deaerated conditions although the INSS work shows that SCC occurs.	Low cycle stressing superimposed on residual stresses.
4	Medium	Medium	Low	Known issue for heavily cold worked stainless steels.	Effect of LiOH concentration in crevices by boiling especially at end of fuel cycle and cycle stretch-out is a concern.
5	Medium	Medium	Low	Known issue for heavily cold worked stainless steels (concn of LiOH?)	
6	Medium	Medium	Low	Known issue for heavily cold worked stainless steels. Mechanistic understanding is a bit shaky at present	Effect on pH of boiling in crevices could be an important consideration
7	Medium	Medium	Low	Known issue for heavily cold worked stainless steels.	Effect of LiOH concentration in crevices by boiling especially at end of fuel cycle and during cycle stretch-out is a concern.
8	Medium	Medium	Low	Known issue for heavily cold worked stainless steels.	Effect of LiOH concentration in crevices by boiling especially at end of fuel cycle and during cycle stretch-out is a concern.

Subgroup **4.9**

Manway retaining bolts
SA-193 Gr B7, PWR primary water
In the event of flange leak
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
44

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Known issue	Always possible if flange leaks
2	Medium	Medium	Medium	Known issue	Always possible if flange leaks
3	Low	High	High	Boric acid on the steel is aggressive. However, inspection should identify such instances.	Lack of inspection
4	Medium	Medium	Medium	Known issue	Always possible if flange leaks
5	Low	Medium	High	Always possible if flange leaks	
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Medium	Medium	Medium	Known issue	Always possible if flange leaks
8	Medium	Medium	Medium	Known issue	Always possible if flange leaks

Subgroup **4.9**

Manway retaining bolts
SA-193 Gr B7, PWR primary water
In the event of flange leak
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
44

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
2	0	High	Medium	No known loading issues.	
3	Low	Medium	Medium	There seems to be little fatigue loading here except possibly for cyclic pressures from load following	Presence of fatigue loading
4	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	Good service experience to date but CUFs not available.
5	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
7	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.

Subgroup
4.9

Manway retaining bolts
SA-193 Gr B7, PWR primary water
In the event of flange leak
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
44

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	not an issue with good practice.
3	Medium	Medium	Medium	These alloys are high strength and are always prone to SCC. Their SCC also depends on heat treatment and metallurgical processing. The presence of cyclic ripple loading is not clear. Unless specific ameliorative actions taken such as shot peening, some SCC should be expected.	Absence of ameliorative actions
4	Low	Medium	Low	Has occurred but not since Molybdenum disulfide lubricants banned. Knowledge score low due to lack of system definition	Not considered a significant future threat.
5	Low	Medium	Low	Has occurred with Molybdenum disulfide lubricants	
6	Low	High	Medium	Has occurred but not since molybdenum disulfide lubricants were banned	Shouldn't be a problem in the future
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.

Subgroup
4.10.1

Austenitic stainless weld HAZs
Type 304, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27,28,29,31,32,33,38,39,41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Note that the heater to sleeve attachment welds, part 27, is a known fatigue sensitive zone.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1" Susceptibility rating increased due to higher temp.	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **4.10.1**

Austenitic stainless weld HAZs
Type 304, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27,28,29,31,32,33,38,39,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs.	Not anticipated to be a long term problem due to negligible dissolved oxygen
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Not anticipated to be a long term problem.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Not anticipated to be a long term problem.

Subgroup **4.10.2**

Austenitic stainless weld HAZs
Type 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27,28,29,31,32,33,38,39,41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Note that the heater to sleeve attachment welds, part 27, is a known fatigue sensitive zone.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1" Susceptibility rating increased due to higher temp.	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **4.10.2**

Austenitic stainless weld HAZs
Type 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
27,28,29,31,32,33,38,39,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs.	Not anticipated to be a long term problem due to negligible dissolved oxygen
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Not anticipated to be a long term problem.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Not anticipated to be a long term problem.

Subgroup
4.11

Dissimilar metal welds
Type 308, 309
External surface

Applies to BNL Part #s with prefix RCS-PZR
17,18,19,20,21,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	--	--	--	Insufficient experience with this cracking mode (i.e. external environment) to make a judgement	
5	Low	High	High	needs moisture and corrosive species concentration (e.g. under deposits) plus high stresses and sensitization	
6	Medium	High	Medium	External cracking is a known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Low	High	High		

Subgroup **4.12**

Dissimilar metal welds
Alloys 82, 182
External surface

Applies to BNL Part #s with prefix RCS-PZR
17,18,19,20,21,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization but less so than in stainless steel case.	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Medium	High	Low	Known issue in dilution zone with low alloy steel leading to sensitization	Specific parameters except Cl not identified.
3	Low	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be more resistant than the Alloy 600 system. It's not clear that there are sufficient data to conclude that these weld metals will not sustain in the residual stresses and stress cycling to which they are exposed.	The necessary conditions for corrosion fatigue or SCC are not clear.
4	0	High	High	Ni alloys resistant to SCC in Cl environments	
5	Low	High	High	needs moisture and corrosive species concentration (e.g. under deposits) plus high stresses and sensitization	
6	Low	Low	Low	Don't know of any lab or field experience with this degradation mode	
7	Low	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	0	High	High	No concern for external Cl on these Ni alloys	

Subgroup
4.13

Forged austenitic nozzles
Types 304, 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
26,32,33,39,41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor + low leakage core issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 8, 11, 17
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects. Thermal cycling due to striping from low leakage cores a concern.	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Medium	Medium	Medium	Probably limited cyclic component.	

Subgroup
4.13

Forged austenitic nozzles
Types 304, 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PZR
26,32,33,39,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination	
6	Low	High	High	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	Medium	Medium	More concern if nozzles have cold work	

Subgroup **4.14**

Heater cladding/attachement weld
Alloy 600, cold worked, PWR primary water
>653°F, 2250 psia
For CE plants

Applies to BNL Part #s with prefix RCS-PZR
27

Notes: for CE Plants

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Similar effect of PWR primary water on fatigue life expected as for austenitic stainless steels.	Only likely to be a problem where present nominal CUF>0.1approx. Note that the heater to sleeve attachment welds, part 27, is a known fatigue sensitive zone.
2	Low	Medium	Medium	Probable lack of data	
3	Low	Medium	Medium	There does not seem to be a significant fatigue condition with oscillating stresses unless the thermal cycling of the heaters produce low frequency thermal stresses. This should be evaluated especially together with residual stresses. There is no significant flow.	Thermal stresses due to heater oscillation.
4	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem
5	Low	Medium	Low	Possible corrosion fatigue	
6	Medium	Medium	Medium	Some lab data.	Not aware of much field experience. Probably not an issue unless the CUF is relatively high
7	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem
8	Medium	Medium	Medium	Expect moderate vibratory loading	

Subgroup
4.14

Heater cladding/attachement weld
Alloy 600, cold worked, PWR primary water
>653°F, 2250 psia
For CE plants

Applies to BNL Part #s with prefix RCS-PZR
27

Notes: for CE Plants

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Known issue for cold worked Alloy 600 in normal quality PWR primary water as well as in concentrated LiOH.	Effect of LiOH concentration in crevices by boiling especially at end of fuel cycle and during cycle stretch-out is an added concern. Attachment weld not subject to thermal flux.
2	High	High	Medium	Known vulnerability	
3	Medium	Medium	Medium	The alloy 600 heater tubes sustain significant SCC that is especially related to residual stresses.	Presence of residual stresses from welding and abusive machining.
4	High	High	Medium	Known vulnerability for alloy 600 only.	Forged alloy 600 SCC a known problem (for other plants)
5	Medium	High	High	Sensitized welds and cold work risk factors	
6	High	High	Medium	Cracking has been experienced in most (or maybe all) CE plants	Mechanism is not well-enough understood to allow the confident definition of a water chemistry mitigation approach. Repair/ replacement using alloys 690/52 and 152 are only available options at present
7	High	High	Medium	Known vulnerability for cold worked alloy 600.	Cold worked alloy 600 SCC a known problem (for other plants)
8	High	Medium	Medium	Expect significant SCC in CW 600 at high temp.	

Subgroup **5.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SPRAY
1-36

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **5.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SPRAY
1-36

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **5.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
10,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Low	Good lab data base but doubts on magnitude of environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **5.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
10,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed

Subgroup **5.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
8,9,10,14,19,20,22,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1"	Very good field experience
5	Low	Medium	Medium	Doubts on environmental effects from laboratory data	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Very good field experience. Only likely to be a problem where present nominal FUF>0.1approx.

Subgroup **5.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
8,9,10,14,19,20,22,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Good field experience. Question if cold work may elevate problem in some plants
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	Medium	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Very good field experience and not anticipated to be a long term problem

Subgroup **5.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
8,9,10,14,19,20,22,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1"	Very good field experience
5	Low	Medium	Medium	Doubts on environmental effects from laboratory data	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Very good field experience. Only likely to be a problem where present nominal FUF>0.1approx.

Subgroup **5.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
8,9,10,14,19,20,22,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue	Good field experience. Question if cold work may elevate problem in some plants
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	Medium	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Very good field experience and not anticipated to be a long term problem

Subgroup **5.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
1,2,3,4,5,6,7,11,12,13,15,16,17,18,21,23,24,25,27,28,29,30,31,32,33,35,36

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 12 to 18
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	Medium	Low	Doubt lab data base is as good as for wrought materials	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but dead legs might be vulnerable to thermal fatigue
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **5.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
1,2,3,4,5,6,7,11,12,13,15,16,17,18,21,23,24,25,27,28,29,30,31,32,33,35,36

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition

Subgroup **5.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
1,2,3,4,5,6,7,11,12,13,15,16,17,18,21,23,24,25,27,28,29,30,31,32,33,35,36

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition

Subgroup **5.5**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
8,9,14,19,22,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume data base for forged materials applies.	Surface finish a known influencing factor
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known problem
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor.
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet. Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Surface finish a known influencing factor
8	Low	Medium	Medium	Assume data base for forged materials applies.	Surface finish a known influencing factor

Subgroup **5.5**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
8,9,14,19,22,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening

Subgroup **5.6**

Socket welds
Types 304, 308, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
6,15,34

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail a flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	High	High	Low	Significant field experience of failures	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Medium	High	Low	Known issue due to design detail a flow induced vibration	
6	High	High	Medium	Failures at multiple plants	Depends on flow induced vibration which is associated with design details.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	High	High	Medium	Significant field experience of failures	Depends on design detail a flow induced vibration

Subgroup **5.6**

Socket welds
Types 304, 308, 316, PWR primary water
556 to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SPRAY
6,15,34

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups. The SCC may be accelerated by corrosion fatigue where the ripple effect accelerates SCC.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Medium	High	Low	Semantics problem with definition of SCC and corrosion fatigue which is highlighted with these components	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Medium	High	Medium	Concern, but probably overwhelmed by corrosion fatigue	

Subgroup **6.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SURGE
1-6

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **6.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SURGE
1-6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **6.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
3,4

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Assume surge line potentially more susceptible to thermal fatigue due to stratification.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects. 2 scoring on susceptibility reflects higher temp.	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Medium	High	High	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.
8	Medium	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.

Subgroup **6.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
3,4
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	Medium	Corrosion fatigue probably dominates	

Subgroup **6.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
3,4,5,6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Assume surge line potentially more susceptible to thermal fatigue due to stratification.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1" Susceptibility rating increased due to higher temp.	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Medium	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF exceeds about 0.1. Assume surge line potentially more susceptible to thermal fatigue.
7	Medium	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results). corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.

Subgroup **6.3.1**

Austenitic piping weld HAZs
Type 304, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
3,4,5,6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue. Susceptibility increase to 2, reflects increase in temp and impact of failure	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Very good field experience but may begin to surface as a long term problem.

Subgroup **6.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
3,4,5,6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Assume surge line potentially more susceptible to thermal fatigue due to stratification.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	Medium	Low	Lab data base is not as extensive as for wrought materials."knowledge" score reduced to "1" Susceptibility rating increased due to higher temp.	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Medium	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF exceeds about 0.1. Assume surge line potentially more susceptible to thermal fatigue.
7	Medium	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results). corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.

Subgroup **6.3.2**

Austenitic piping weld HAZs
Type 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
3,4,5,6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue. Susceptibility increase to 2, reflects increase in temp and impact of failure	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Very good field experience but may begin to surface as a long term problem.

Subgroup **6.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
1,2,6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Assume surge line potentially more susceptible to thermal fatigue due to stratification.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Low	Doubt lab data base is as good as for wrought materials. "Knowledge "score reduced to "1" Elevated susceptibility to 2 because of increased temp	Only likely to be a problem where present nominal CUF>0.1 approx. Assume surge line potentially more susceptible to thermal fatigue.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however).	Unlikely in the field unless the CUF is fairly high but assume surge line might be more vulnerable to thermal fatigue
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Assume surge line potentially more susceptible to thermal fatigue.

Subgroup **6.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
1,2,6

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition

Subgroup **6.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
1,2,6
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	HAZ is a bigger concern, but aging of weld metals may create a problem. Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **6.5**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
5,6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Assume lab data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor. Assume surge line potentially more susceptible to thermal fatigue due to stratification.
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Assume lab data base for wrought materials applies. Doubts on magnitude of environmental effect	Surface finish a known influencing factor. Assume surge line potentially more susceptible to thermal fatigue.
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Medium	Medium	Medium	Assume lab data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor. Assume surge line potentially more susceptible to thermal fatigue.
7	Medium	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results). corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Surface finish a known inflluencing factor. Assume surge line potentially more susceptible to thermal fatigue.
8	Medium	Medium	Medium	Assume lab data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor. Assume surge line potentially more susceptible to thermal fatigue.

Subgroup **6.5**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
5,6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening

Subgroup **6.6**

Socket welds
Types 304, 308, 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
5

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	High	High	Low	Significant field experience of failures	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Medium	High	Low	Known issue due to design detail a flow induced vibration	
6	High	High	Medium	Failures at multiple plants	Depends on flow induced vibration which is associated with design details.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	High	High	Medium	Significant field experience of failures	

Subgroup **6.6**

Socket welds
Types 304, 308, 316, PWR primary water
620 to 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SURGE
5

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups. The SCC may be accelerated by corrosion fatigue where the ripple effect accelerates SCC.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Medium	High	Low	Semantics problem with definition of SCC and corrosion fatigue which is highlighted with these components	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Medium	High	Medium	Concern, but probably overwhelmed by corrosion fatigue	

Subgroup **7.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-PORV
1-21

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **7.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-PORV
1-21

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **7.2**

Wrought austenitic stainless steel piping
Types 304, 316 Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
6,12

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Low	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects. Since stagnant steam, thermal cyclic loading likely to be low	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Low	High	Low	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Only likely to be a problem where present nominal CUF>0.1approx. Assume surge line potentially more susceptible to thermal fatigue.
8	Low	High	Medium	Good lab data base but doubts on magnitude of environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.

Group **7** **Reactor Coolant System** **Pressurizer Piping, PORVs**

Subgroup **7.2**

Wrought austenitic stainless steel piping
Types 304, 316 Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
6,12
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening

Subgroup **7.3.1**

Austenitic components weld HAZs
Type 304, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
2,5,6,8,10,12,14,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Low	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Doubt lab data base is as good as for wrought materials. Since stagnant steam, thermal cyclic loading likely to be low	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF exceeds about 0.1.
7	Medium	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results). corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **7.3.1**

Austenitic components weld HAZs
Type 304, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
2,5,6,8,10,12,14,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Good field experience - possibly some field examples of cracking due to SCC	Not anticipated to be a long term generic problem due to negligible oxygen
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue, Susceptibility increase to 2, reflects increase in temp and impact of failure.	Very good field experience and not anticipated to be a long term problem
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS. Higher temperature here makes SCC more likely.	Not anticipated to be a long term problem due to negligible oxygen

Subgroup **7.3.2**

Austenitic components weld HAZs
Type 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
2,5,6,8,10,12,14,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Low	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Doubt lab data base is as good as for wrought materials. Since stagnant steam, thermal cyclic loading likely to be low	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF exceeds about 0.1.
7	Medium	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results). corrosion fatigue susceptibility after low temperature aging (LTA) is not clear.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue. LTA effects is not clear yet.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **7.3.2**

Austenitic components weld HAZs
Type 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
2,5,6,8,10,12,14,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Good field experience - possibly some field examples of cracking due to SCC	Not anticipated to be a long term generic problem due to negligible oxygen
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue, Susceptibility increase to 2, reflects increase in temp and impact of failure.	Very good field experience and not anticipated to be a long term problem
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	Very good field experience - no known cracking due to SCC of HAZs but SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS. Higher temperature here makes SCC more likely.	Not anticipated to be a long term problem due to negligible oxygen

Subgroup **7.4**

Austenitic to austenitic weld metals
Type 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
1,3,4,7,9,11,13,15,16,17,19,20,21

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Low	Doubt lab data base is as good as for wrought materials. Increase in susc. to 2 reflects higher temp.	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	Medium	Medium	plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF exceeds about 0.1.
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **7.4**

Austenitic to austenitic weld metals
Type 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
1,3,4,7,9,11,13,15,16,17,19,20,21

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition

Subgroup **7.4**

Austenitic to austenitic weld metals
Type 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
1,3,4,7,9,11,13,15,16,17,19,20,21

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition

Subgroup **7.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
2,5,8,10,14,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubts on magnitude of environmental effects for fatigue life particularly in view of likely concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line. Surface finish a known influencing factor
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known influencing factor
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known influencing factor
7	Low	Medium	Medium	Significant reduction of fatigue life in 316 at low frequency corrosion fatigue(Japanese EFT results)	Surface finish a known influencing factor
8	Medium	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known influencing factor

Subgroup **7.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
2,5,8,10,14,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening

Subgroup **7.6**

Socket welds
Types 304, 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
4

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	High	High	Low	Significant field experience of failures	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management
5	Medium	High	Low	Known issue due to design detail and flow induced vibration	
6	Medium	Medium	Medium	Failures at multiple plants	Depends on flow induced vibration which seems unlikely in a normally stagnant system
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	High	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **7.6**

Socket welds
Types 304, 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-PORV
4

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups. The SCC may be accelerated by corrosion fatigue where the ripple effect accelerates SCC.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Medium	High	Low	Semantics problem with definition of SCC and corrosion fatigue which is highlighted with these components	Depends on design and material detail; knowledge insufficient to allow adequate mitigation management of FIV
6	Low	Medium	Medium	Very good field experience to date	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.

Subgroup **8.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SRV
1-9

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **8.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SRV
1-9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **8.2**

Wrought austenitic stainless steel piping
Types 304,316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
4

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Low	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Low	Good lab data base but doubts on magnitude of environmental effects. Since stagnant steam, thermal cyclic loading likely to be low	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **8.2**

Wrought austenitic stainless steel piping
Types 304,316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
4

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening

Subgroup **8.3.1**

Austenitic piping weld HAZs
Type 304, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
2,4,9

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Low	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Doubt lab data base is as good as for wrought materials. Since stagnant steam, thermal cyclic loading likely to be low	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **8.3.1**

Austenitic piping weld HAZs
Type 304, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
2,4,9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good field experience - possibly some field examples of cracking due to SCC	Not anticipated to be a long term problem due to negligible oxygen
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue, Susceptibility increase to 2, reflects increase in temp and impact of failure.	Very good field experience and not anticipated to be a long term problem
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible oxygen
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS. Higher temperature here makes SCC more likely.	Not anticipated to be a long term problem due to negligible oxygen

Subgroup **8.3.2**

Austenitic piping weld HAZs
Type 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
2,4,9

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Low	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Low	Doubt lab data base is as good as for wrought materials. Since stagnant steam, thermal cyclic loading likely to be low	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Probably not likely in the field unless the CUF is relatively high
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **8.3.2**

Austenitic piping weld HAZs
Type 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
2,4,9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good field experience - possibly some field examples of cracking due to SCC	Not anticipated to be a long term problem due to negligible oxygen
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue, Susceptibility increase to 2, reflects increase in temp and impact of failure.	Very good field experience and not anticipated to be a long term problem
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible oxygen
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS. Higher temperature here makes SCC more likely.	Not anticipated to be a long term problem due to negligible oxygen

Subgroup **8.4**

Austenitic to austenitic weld metals
Type 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
1,3,5,6,7,8

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubts on magnitude of environmental effects for fatigue life particularly in view of possible concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Low	Doubt lab data base is as good as for wrought materials. Increase in susc. to 2 reflects higher temp.	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF exceeds about 0.1.
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **8.4**

Austenitic to austenitic weld metals
Type 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
1,3,5,6,7,8

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition

Subgroup **8.4**

Austenitic to austenitic weld metals
Type 308, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
1,3,5,6,7,8

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition

Subgroup **8.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
2,9

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubts on magnitude of environmental effects for fatigue life particularly in view of likely concentration of hydrogen in the steam phase	Fatigue loading of normally stagnant line. Surface finish a known influencing factor
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects	Surface finish a known influencing factor
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Low	Medium	Medium	Assume data base for wrought materials applies	Surface finish a known influencing factor
7	Low	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor
8	Medium	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor

Subgroup **8.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Stagnant saturated steam/condensate
PWR primary water, 653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SRV
2,9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening

Subgroup **9.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-RCP
1,2
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **9.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-RCP
1,2
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **9.2**

Stainless steel (internals including weldments)
Types 304, 308, 316, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
4

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Internal fillet welds vulnerable	Design specific
2	Medium	Medium	Medium	Internal fillet welds vulnerable as are other internal parts, depending upon design	Should be caught by maintenance
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Medium	Internal fillet welds vulnerable	Design specific
5	Medium	Medium	Low	Internal fillet welds vulnerable	
6	Medium	Medium	Medium	Internal fillet welds vulnerable	Design specific. Effects of ripple stresses may be important
7	Medium	Medium	Medium	Internal fillet welds vulnerable	Design specific
8	Medium	Medium	Medium	Internal fillet welds vulnerable	Design specific

Subgroup
9.2

Stainless steel (internals including weldments)
Types 304, 308, 316, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
4

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Hypothetical under these conditions but has not been studied sufficiently to eliminate.	Only applicable to weldments
4	Low	Medium	Medium	Unclear fracture embrittlment mechanism;hence lower confidence rating. Lower knowledge rating mirroring lack of FR data in the environment, and unquantified effect of weld constraints.	
5	Low	Medium	Medium	highly stressed welds likely susceptible	
6	Low	Medium	Medium	FR concern is thermal embrittlement of weldments for which in-environment J-R data are sparse	
7	Medium	High	High	Thermal aging embrittlement of duplex SS can be a concerns after a long term aging at service temperature	Spinodal decomposition and this pahse splitting microstructure may increase PWSCC susceptibility.
8	Low	High	High		

Subgroup **9.2**

Stainless steel (internals including weldments)
Types 304, 308, 316, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
4

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known cracking due to IGSCC	Not anticipated to be a problem due to negligible oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	Medium	Medium	St St washers have cracked presumably due to high stress, high yield & surface condition overcoming beneficial effect of low potential	Not anticipated to be a generic problem due to negligible oxygen, and recognized (i.e. manageable) yield stress effects.
5	Medium	Medium	Medium	Martensitic stainless steels vulnerable if too hard & highly strained 304	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Medium	Medium	Medium	No known cracking due to IGSCC	Not anticipated to be a problem due to negligible oxygen.

Subgroup **9.3**

Internal high strength parts (Including pump shaft)
A-286, 17-4PH, X750, 403, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
6,7

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Corrosion fatigue cited for some bolt failures	Design specific. Initiation can be accelerated if any intergranular corrosion.
2	Medium	High	Medium	Could be vulnerable depending on design	
3	Low	Medium	Medium	Failure of pump shafts seems infrequent but bolts seem relatively frequent. The pump shafts seem largely a corrosion fatigue type of application and the bolts seem largely an SCC application.	Minimize surface defects.
4	Medium	Medium	Medium	Corrosion fatigue cited for some bolt failures	Design specific. Initiation can be accelerated if any intergranular corrosion.
5	Medium	Medium	Medium	Corrosion fatigue cited for some bolt failures	
6	Medium	Medium	Medium	Corrosion fatigue cited for some bolt failures	Design specific. Initiation can be accelerated if any intergranular corrosion.
7	Medium	Medium	Medium	Corrosion fatigue cited for some bolt failures	Design specific. Initiation can be accelerated if any intergranular corrosion.
8	Medium	Medium	Medium	Corrosion fatigue cited for some bolt failures	Design specific. Initiation can be accelerated if any intergranular corrosion.

Subgroup **9.3**

Internal high strength parts (Including pump shaft)
A-286, 17-4PH, X750, 403, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
6,7

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue for 17-4PH	Depends on temper and operating temperature
2	Medium	High	Medium	Known issue for 17-4PH	Depends on temper and operating temperature
3	Medium	Medium	Medium	Lower fracture toughness than many other structural materials. This fracture toughness is relatively high at operating temperature but much lower in the RT range.	Lower fracture toughness at lower temperatures
4	Medium	High	Low	Known issue for 17-4PH ; X-750 definite problem with LTCP, which has yet to be quantified with respect to operating conditions	Depends on temper and operating temperature
5	Medium	High	Low	Known issue for 17-4PH (depending on temper)	
6	Medium	High	Medium	Known issue for 17-4PH. [A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals. Alloy X750 is particularly susceptible. In this case the score would be Low-Low-Low].	Depends on temper and operating temperature. [For X750, it's not clear if the conditions required for LTCP are met in PWR service. The likelihood appears greatest during cooldown (<150C)]
7	Medium	High	Medium	Known issue for 17-4PH. Reduction of toughness? Or Subcritical crack growth?	Depends on temper and operating temperature
8	Medium	High	Low	Known issue for 17-4PH	Depends on temper and operating temperature

Subgroup **9.3**

Internal high strength parts (Including pump shaft)
A-286, 17-4PH, X750, 403, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
6,7

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue for A-286, 17-4PH (depending on temper) and X750. Martensitic stainless steels vulnerable if too hard. Also highly strained 304	As fabricated hardness if >~350HV and evolution with time in case of 17-4PH
2	Medium	High	Medium	Known issue for A-286, 17-4PH (depending on temper) and X750 (depends on HT). Martensitic stainless steels vulnerable if too hard. Also highly strained 304	As fabricated hardness if >~350HV and evolution with time in case of 17-4PH
3	Medium	Medium	Medium	High strength bolts sustain SCC relatively often and need to be constantly inspected. Bolting has been improved by heat treatment and variations on short peening or other surface treatments. Such bolts need to avoid overstressing. Crack growth accelerated with stress ripples.	Over stress and lack of inspection as well as the high strength itself are continuing problems
4	High	High	Medium	Known issue for A-286, 17-4PH (depending on temper) and X750. Martensitic stainless steels vulnerable if too hard. Also highly strained 304	As fabricated hardness if >~350HV and evolution with time in case of 17-4PH
5	High	High	High	Known issue for A-286, 17-4PH (depending on temper) and X750	
6	Medium	High	Medium	Known issue for A-286, 17-4PH (depending on temper) and X750. Martensitic stainless steels vulnerable if too hard. Also highly strained 304	As fabricated hardness if >~350HV and evolution with time in case of 17-4PH
7	Medium	High	Medium	Known issue for A-286, 17-4PH (depending on temper) and X750. Martensitic stainless steels vulnerable if too hard. Also highly strained 304	As fabricated hardness if >~350HV and evolution with time in case of 17-4PH
8	High	High	Medium	Known issue for A-286, 17-4PH (depending on temper) and X750. Martensitic stainless steels vulnerable if too hard. Also highly strained 304	As fabricated hardness if >~350HV and evolution with time in case of 17-4PH

Subgroup **9.4**

Forged austenitic flange
Type 304, PWR primary water
120°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
4,5
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor
2	Low	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Low	Medium	Low	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service. Low temp likely to reduce magnitude of this problem	Surface finish a known influencing factor
5	Low	Low	Low	Surface finish and cold work a known issue	
6	Low	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish is a known influencing factor
7	Low	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor
8	Low	Medium	Medium	Assume data base for wrought materials applies - doubts on magnitude of environmental effects in service	Surface finish a known influencing factor

Subgroup **9.4**

Forged austenitic flange
Type 304, PWR primary water
120°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
4,5

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Very good field experience.	Not anticipated to be a problem under normal operating conditions
3	Low	Medium	Medium	Good performance in field. Concern if not stress relieved owing to cold work.	
4	Low	High	High	Unlikely at low temperature and low corrosion potential	
5	Low	High	High	Unlikely unless heavily cold worked or sensitized and exposed to oxidizing conditions; possible at shutdowns?	
6	Low	Medium	High	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	SCC may take place in conjunction with ripple stresses.	Ripple stresses.
8	Low	High	High		

Subgroup **9.5**

Cast stainless steel
CF8, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
1,2

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF > 0.1
3	Low	Medium	--	Good field performance; SCC work is still not convincing	
4	Medium	Medium	Medium	Fatigue always possible in pump casing. Lower confidence and knowledge scores mirroring the lack of data in the environment over a representaive range of environments and loading histories	
5	Low	High	High	thick sections so vibrations not expected to be large enough to cause fatigue failures	
6	Low	Medium	Medium	Assume lab database for wrought materials applies	Surface finish is a known influencing factor
7	Low	High	High	SCC/Fatigue may take place in conjunction with ripple stresses.	Ripple stresses.
8	Low	High	High		

Subgroup **9.5**

Cast stainless steel
CF8, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
1,2
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Known, well characterized issue. Static casting therefore possible embrittlment, but low stress mitigates this. Lower knowledge score indicates uncertainty about certain heats (see CASS topical)	Known issue. Effective prediction models.
5	--	Low	Low		
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service.
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition. Hydrogen may play a critical role in cracking. Not necessary by hydrogen embrittlement.
8	Medium	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models.

Subgroup **9.5**

Cast stainless steel
CF8, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RCP
1,2
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating a testing program in Europe to assess long term risk
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA:spinodal decomposition) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with aging	Sufficient doubts to initiate testing program in Europe to assess long term risk

Subgroup **9.6**

Main flange bolts
SA-540 Gr. B24
Containment air
Hot due to PWR primary water temperature

Applies to BNL Part #s with prefix RCS-RCP
3
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Known issue	Always possible if flange leaks
2	Medium	Medium	Medium	Known issue	Always possible if flange leaks
3	Low	High	High	Boric acid on the steel is aggressive. However, inspection should identify such instances.	Lack of inspection
4	Medium	Medium	Medium	Always possible if flange leaks	Always possible if flange leaks
5	Low	Medium	High	Always possible if flange leaks	
6	Medium	Medium	Medium	Known issue	Always possible if flange leaks
7	Medium	Medium	Medium	Known issue	Always possible if flange leaks
8	Medium	Medium	Medium	Known issue	Always possible if flange leaks

Subgroup **9.6**

Main flange bolts
SA-540 Gr. B24
Containment air
Hot due to PWR primary water temperature

Applies to BNL Part #s with prefix RCS-RCP
3
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
2	0	High	Medium	No known loading issues.	
3	Low	Medium	Medium	There seems to be little fatigue loading here except possibly for cyclic pressures from load following	Presence of fatigue loading
4	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	Good service experience to date but CUFs not available.
5	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
7	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.

Subgroup **9.6**

Main flange bolts
SA-540 Gr. B24
Containment air
Hot due to PWR primary water temperature

Applies to BNL Part #s with prefix RCS-RCP
3
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	
3	Medium	Medium	Medium	These alloys are high strength and are always prone to SCC. Their SCC also depends on heat treatment and metallurgical processing. The presence of cyclic ripple loading is not clear. Unless specific ameliorative actions taken such as shot peening, some SCC should be expected.	Absence of ameliorative actions
4	Low	Medium	Low	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
5	Low	Medium	Low	Has occurred but not since Molybdenum disulfide lubricants banned	
6	Low	High	Medium	Has occurred but not since molybdenum disulfide lubricants banned	Not considered a significant future threat.
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	Medium	Low	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.

Subgroup **10.1**

Any stainless steel components
External surfaces when at <150°C
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-RPV
8,9,10,11,26

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **10.1**

Any stainless steel components
External surfaces when at <150°C
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-RPV
8,9,10,11,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **10.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
1,2,3,4,5,6,7,16,17,23,24,25,31

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
2	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
3	Medium	High	High	The boric acid corrosion is no issue if there are not SCC events at welds or cracking prone alloys. However, BAC is rapid when the boric acid is hot and concentrated and at high velocities.	Depends of SCC at penetrations.
4	High	High	Low	Boric acid corrosion of low alloy steels due to leaks at seals or associated with alloy 600/182/82 welds at penetrations. Low knowledge value given to reflect specifically the conditions in annulus of VHPs	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
5	Medium	High	High	BA leakage from cracked welds	
6	Medium	High	Medium	External boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
7	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
8	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat

Subgroup
10.2

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
1,2,3,4,5,6,7,16,17,23,24,25,31

Notes:

Thermal Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Very unlikely based on fossil boiler experience	Temperature too low based on fossil boiler experience
2	Low	Low	Medium	On-going studies have not been able to eliminate concern for nozzles	Nozzle loading conditions
3	Low	Medium	Medium	Not clear here whether this is radiation induced creep or thermal creep or both. The flux may be too low for radiation induced creep.	This does not look promising as an option.
4	0	High	High	Unlikely to be a practical problem based on fossil boiler experience and relatively low homoglous temperature.	Temperature too low based on fossil boiler experience
6	0	High	High	Very unlikely based on fossil boiler experience. Lots of lab data indicate the same conclusion.	Temperature too low based on lab data and fossil boiler experience
7	Low	Low	Low	Very unlikely based on fossil boiler experience	Temperature too low based on fossil boiler experience
8	Low	High	High	Very unlikely based on fossil boiler experience	Temperature too low based on fossil boiler experience

Subgroup **10.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
1,2,3,4,5,6,7,16,17,23,24,25,31

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Not normally exposed to PWR primary water but can be after repairs to upper or lower head penetrations (Parts 18,19,20, 29,30)	Not anticipated to be a problem due to negligible dissolved oxygen except possibly during shutdown.
2	--	--	--	only theoretical problem if cladding penetrated	
3	Low	Medium	Medium	Since the steel is not adjacent to water, this is not likely unless there is a breach of the cladding or a breach of a penetration. The action of a crevice would contribute to pitting or local penetrations that might affect the initiation of either or both SCC and corrosion fatigue.	Disbond of clad or some crevice geometry in a deposit. Possibly water on the outside under a deposit.
4	Low	High	Medium	No observations to date. However may be possible under leakage situations where O2 supply assured to give required electrochemical conditions	Highly dependent on specifics of penetration designs.
6	Low	Medium	Medium	Generally good experience to date but some potential for damage exists	Not expected to be a significant damage form under plant service conditions
7	Low	Medium	Medium	Potential problem with oxygen addition.	Potential.
8	Low	High	High		

Subgroup **10.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
1,2,3,4,5,6,7,16,17,23,24,25,31

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good experience, theoretical risk of corrosion fatigue/SCC if clad penetrated	Failure of austenitic weld clad and components with potentially high CUF such as inlet and outlet nozzles and welds (parts 6,7,25)
2	Low	High	High	Only an issue under very specific loading conditions	
3	Low	High	Medium	The plates are covered by what has historically been a good cladding. Thus, corrosion fatigue from the inside may not be significant. There is the possible fatigue due to cycling at shutdowns of long times and the resulting high stresses in the steel at the clad steel interface. However, this is not a corrosion fatigue issue	Access of water to the surface.
4	Low	High	High	Good experience, theoretical risk of corrosion fatigue/SCC if clad penetrated	Failure of austenitic weld clad
5	Low	High	High	Good experience, theoretical risk of corrosion fatigue/SCC if clad penetrated	
6	Low	High	High	Possibility of corrosion fatigue if clad is penetrated has been studied extensively. Design CUF's of components such as nozzles are misleadingly high because load following was assumed. For constant power operation, actual EOL CUF's are projected to be very small even when EAC and life extension are factored in.	Failure of austenitic weld clad is necessary precursor. Decision to move to load-following operation would greatly increase CUFs for some components. Field experience has been good to date.
7	Low	High	High	Good experience, theoretical risk of corrosion fatigue/SCC if clad penetrated	Failure of austenitic weld clad
8	Low	High	High	Good experience, theoretical risk of corrosion fatigue/SCC if clad penetrated	Failure of austenitic weld clad

Subgroup
10.2

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
1,2,3,4,5,6,7,16,17,23,24,25,31

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience due to excellent SCC resistance of stainless steel cladding.	Not anticipated to be a long term problem due to effective isolation from the aqueous environment.
2	0	High	Medium	only theoretical problem if cladding penetrated	
3	Low	Medium	Medium	The PV steels are prone to SCC but less at low potentials. The inside surface of the vessel is clad so this is nominally not a problem here. Could occur from outside from a moist location where moisture is somehow sequestered.	Water on outside, debond on inside.
4	Low	High	Medium	Highly unlikely in these PWR environments unless there is an oxidizing species present that would counteract the H2 reducing effect	
6	Low	High	High	Generally good experience to date but some potential for damage exists	Not expected to be a significant damage form under plant service conditions
7	Low	High	High	Very unlikely based upon Lab. Data so far.	Any hardening possible?
8	Low	High	Medium		

Subgroup **10.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2 or SA-508 Cl.2, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
3,23
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Known issue for beltline - predictive models exist	Cu and P content + neutron dose
2	Medium	High	High	Beltline region most affected. Surveillance programs in place.	Depends on material composition
3	Low	High	Medium	The fracture resistance of reactor pressure vessel steels has been extensively studied and seems to be adequate so long as the temperatures are above some threshold. Whether this persists to long times in re-licensing times is not clear. Also, radiation affects the proneness to SCC in the sense of acting like cold work.	Longer times should be considered.
4	Medium	High	High	Known issue for beltline - predictive models exist and regulatory position and revised RGs well in place	Cu and P content + neutron dose
5	Medium	High	High	Known issue	
6	Medium	High	High	Known issue for beltline - well-documented predictive models exist	Cu and P content + neutron dose
7	Medium	High	High	Known issue for beltline - predictive models exist	Cu and P content + neutron dose
8	Medium	High	High	Known issue for beltline - predictive models exist	Cu and P content + neutron dose

Subgroup **10.3**

Stainless steel welds and cladding
Types 308, 309, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
10,11

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good field experience. Underclad cracks a fabrication issue.	No problems anticipated in normal PWR primary water with negligible oxygen. Excessive dilution of stainless clad may give potentially susceptible microstructure
2	Low	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
3	Low	Medium	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite.	Special surface conditions on welds.
4	Low	High	High	Good field experience - no known service SCC although cracking can occur at low rates if ferrite present	No problems anticipated due to negligible oxygen
5	Low	High	High	Good field experience	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	Good field experience - no known service IGSCC	No problems anticipated due to negligible oxygen
8	Low	High	High	HAZ is a bigger concern, but aging of weld metals may create a problem. Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	No problems anticipated due to negligible oxygen

Subgroup **10.3**

Stainless steel welds and cladding
Types 308, 309, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
Cladding Material
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good field experience - a few known clad failures - probably mainly due to fabrication problems	Underclad fabrication cracks. Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld clad uncertain.
2	Low	Low	Low	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Good field experience - a few known clad failures - probably mainly due to fabrication problems	Underclad cracks
5	Low	High	High	Good field experience - a few known clad failures	
6	Low	High	High	Good field experience - a few known clad failures - probably mainly due to fabrication problems	Fabrication defects in clad
7	Low	High	High	Good field experience - a few known clad failures - probably mainly due to fabrication problems	Underclad cracks
8	Low	High	High	Good field experience - a few known clad failures - probably mainly due to fabrication problems	Underclad cracks

Subgroup **10.3**

Stainless steel welds and cladding
Types 308, 309, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
Cladding Material
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld deposits susceptible to thermal aging but less so than in cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Martensite phase at low alloy steel interface due to excessive weld heat input can and has cracked - fabrication issue	Known issue. Effective prediction models for austeno-ferritic weld deposits.
2	Low	Medium	Medium	Hypothetical under these conditions but has not been studied sufficiently to eliminate.	
3	Low	Medium	Medium	Concern is mainly with low temperature. Good field performance. Data for FR at high temperature is not convincing	
4	Low	Medium	Medium	Unclear fracture embrittlment mechanism;hence lower confidence rating. Lower knowledge rating mirroring lack of FR data in the environment, and unquantified effect of weld constraints.	
5	Low	Medium	Medium	highly stressed welds likely susceptible	
6	Low	Medium	Medium	FR concern is thermal embrittlement/aging of weldments and clad for which in-environment J-R data are sparse	
7	Medium	High	High	Thermal aging embrittlement of duplex SS can be a concerns after a long term aging at service temperature	Spinodal decomposition and this pahse splitting microstructure may increase PWSCC susceptibility.
8	Low	High	High		

Subgroup **10.3**

Stainless steel welds and cladding
Types 308, 309, PWR primary water
556°F to 559°F, 600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
Vessel head flange seal faces

Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Steam cutting of main closure head seal faces possible in the event of seal leaks	Head to pressure vessel seal leaks
2	Low	Medium	Medium	Steam cutting of main closure head seal faces possible in the event of seal leaks	Head to pressure vessel seal leaks
3	0	Low	Low	Where does erosion corrosion occur on welds?	
4	Low	Medium	Medium	Steam cutting of main closure head seal faces possible in the event of seal leaks	Head to pressure vessel seal leaks
6	Low	Medium	Medium	Steam cutting of main closure head seal faces possible in the event of seal leaks	Head to pressure vessel seal leaks
7	Low	Medium	Medium	Steam cutting of main closure head seal faces possible in the event of seal leaks	Head to pressure vessel seal leaks
8	Low	Medium	Medium	Steam cutting of main closure head seal faces possible in the event of seal leaks	Head to pressure vessel seal leaks

Subgroup
10.4

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
8,9
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Medium	Dissimilar expansion coeffs in case of stainless steel filler metals + possible environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem if design CUF exceeds about 0.1. Field experience has been good to date
7	Medium	Medium	Medium	Dissimilar expansion coeffs in case of stainless steel filler metals + possible environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Dissimilar expansion coeffs in case of stainless steel filler metals + possible environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **10.4**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
8,9

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld deposits susceptible to thermal aging but less so than in cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Martensite phase at low alloy steel interface due to excessive weld heat input can and has cracked - fabrication issue	Known issue. Effective prediction models for austeno-ferritic weld deposits.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism

Subgroup **10.4**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
8,9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen	Hydrogenated primary water ensuring no dissolved oxygen.
2	Low	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
5	Medium	High	Low	Known issue in dilution zone with welds to low alloy steel - sensitization	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic weld metals due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	RPV dissimilar metal welds vulnerable to wetting during refueling. This cracking can also occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	RPV dissimilar metal welds vulnerable to wetting during refueling. This cracking can also occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.

Subgroup **10.5**

Forged austenitic nozzles
Types 304, 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought austenitic materials applies.	Surface finish a known influencing factor. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Surface finish and cold work a known problem	
6	Low	Medium	Medium	Good field experience to date but this is a known vulnerability	Only likely to be a problem where CUF exceeds about 0.1.
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **10.5**

Forged austenitic nozzles
Types 304, 316, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	High	High	Medium	Forged alloy 600 SCC a generic problem	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions

Subgroup **10.6**

Closure studs/nuts
SA-540 Gr B23, Cl.3, PWR primary water
In the event of flange leak
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
27
Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Known issue	Always possible if flange leaks
2	Medium	Medium	Medium	Known issue	Always possible if flange leaks
3	0	Low	Low	I don't see the geometry here for steam cutting.	This would require a leak resulting from some SCC in another component. If the leak occurs, then EC might result.
4	Medium	High	Medium	Always possible if flange leaks - flange is also damaged. Reasonable management programs in place to address the bolting BAC problems	
5	Medium	Medium	High	possible if impinging leakage directed on to metal surface	
6	Medium	Medium	Medium	Known issue	Always possible if flange leaks
7	Medium	Medium	Medium	Known issue	Always possible if flange leaks
8	Medium	Medium	Medium	Known issue	Always possible if flange leaks

Subgroup
10.6

Closure studs/nuts
SA-540 Gr B23, Cl.3, PWR primary water
In the event of flange leak
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
27
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
2	0	High	Medium	No known loading issues.	
3	Low	Medium	Medium	The corrosion fatigue will be most likely an interaction with SCC and ripple loading. Some possible crevice action and pitting might accelerate initiation of corrosion fatigue	Wetness, deposits, shutdowns, oxygen, pitting.
4	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	Good service experience to date but CUFs not available.
5	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	
6	Low	Medium	Medium	Good service experience to date but may be a vulnerability	Probably only a concern where CUF's are relatively high
7	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.

Subgroup **10.6**

Closure studs/nuts
SA-540 Gr B23, Cl.3, PWR primary water
In the event of flange leak
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
27
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	
3	Low	Medium	Medium	Steels at high strengths are always prone to SCC especially if no mitigation has been performed. Such bolts also must be wet and it is not clear that they will be generally wet except under accident conditions.	Wetness, deposits, shutdowns, oxygen, pitting.
4	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned. Adequate yield stress specifications in place	Not considered a significant future threat.
5	Low	Medium	High	Always possible if flange leaks - flange is also damaged	
6	Low	High	Medium	Has occurred but not since molybdenum disulfide lubricants were banned	Not considered a significant future threat.
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.

Subgroup **10.7**

Cast stainless steel components
CF8, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
11

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
2	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials. Reasonable field experience so far. Increase in Susc.	
5	Low	High	High	needs high cyclic stresses plus high residual stresses	
6	Low	Medium	Medium	Assume lab database for wrought materials applies	Surface finish is a known influencing factor
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. LTA in corrosion fatigue is not clear yet.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain.
8	Low	Medium	Medium		

Subgroup **10.7**

Cast stainless steel components
CF8, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
11

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical) which lowers knowledge score	Known issue. Effective prediction models.
5	--	Low	Low		
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service.
7	Low	High	High	Well characterized	Known issue. Effective prediction models.
8	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models.

Subgroup
10.7

Cast stainless steel components
CF8, PWR primary water
556°F to 559°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
11

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
7	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with aging	Sufficient doubts to initiate testing program in Europe to assess long term risk

Subgroup
10.8

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
8,9,12,13,14,15,18,19,20,21,22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
2	Medium	Medium	Low	anticipated by thermohydraulic calculations with low leakage core loading	
3	Medium	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where nominal CUF is greater than about 0.1
7	High	High	High	Depending upon loading mode but EAC can take place.	
8	Medium	High	Medium		

Subgroup
10.8

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
8,9,12,13,14,15,18,19,20,21,22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fully austenitic - toughness not an issue	
2	Low	Medium	Medium	Lack of data in environment	
3	Medium	Medium	Medium	The existing Mills data show that the main loss of fracture resistance occurs at low temperate and that the 690 type is more prone to lose toughness than the 600. However, these patterns are not yet well defined. Nonetheless, careful attention should be given to operating conditions where the Alloy 600 base is exposed to lower temperatures and possibly some concern at higher temperatures	Lower temperatures more likely to produce lower fracture resistance for 600 base although greater degradation seems to occur in the 690 base
4	Medium	High	Low	There is a potential LTCP problem with these materials and also for replacement 52/152	The specific danger is dependent on the T/t transients and whether these can occur during normal or severe accident operation. This necessary knowledge does not currently exist.
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals	It's not clear if the conditions required for LTCP in lab tests are met in PWR service. The likelihood appears greatest during cooldown.
7	Low	High	High	SCC crack growth can take place under low loading rate and it impact to J-R curves. The initiation J is not toughness.	Loading rate
8	Medium	Medium	Medium		

Subgroup **10.8** Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
8,9,12,13,14,15,18,19,20,21,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Generic issue for alloys 82/182.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.
2	High	High	Medium	Generic issue for alloys 82/182.	Insufficient understanding of problem, and need for development of inspection and prediction tools
3	High	High	High	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear. Certainly cyclic ripples will accentuate the SCC.
4	High	High	Low	IGSCC in PWR primary water a generic issue for alloys 600/82/182 only. Lower value for "knowledge" reflects life management concerns following VC Summer hot leg and VHP incidents. We have poor predictive capabilities for e.g. composition effects and little assurance that mitigation actions associated with 690/152/52 will be fully effective. "Good" experience with replacement SG tubes not necessarily relevant. Poor specs for welding procedures for these high Cr alloys.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.
5	Medium	High	Low	Known issue in dilution zone with welds to low alloy steel - sensitization	
6	High	High	Medium	Generic issue for alloys 82/182.	Long and very variable crack initiation times and unpredictable crack growth rates. No fully qualified chemistry mitigation actions available
7	High	High	High	IGSCC in PWR primary water a generic issue for alloys 82/182 only	Expected after ~130,000 EFPhours exposure to PWR primary water.
8	High	High	High	IGSCC in PWR primary water is a generic issue for alloys 82/182.	Expected after ~130,000 EFPhours exposure to PWR primary water.

Subgroup
10.9

Forged austenitic nozzles
Alloy 600, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
28,29,30

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought austenitic materials applies.	Surface finish a known influencing factor. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Assume lab data for wrought materials applies.	Surface finish is a known influencing factor. Only likely to be a problem where present nominal CUF > 0.1.
3	Low	Medium	Medium	Good performance in field. Concern if not stress relieved owing to cold work.	
4	Medium	Medium	High	Enhanced fatigue susceptibility for stainless steels certainly possible at low potentials. Degree a sensitive function of loading conditions; hence lowered confidence score	
5	Low	High	High	A concern only if components can be subject to significant vibration; thick section components unlikley to be affected	
6	Low	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Low	High	High	Environmrntal effects on an usage factor may need more to be characterize.	Strain rate.
8	Low	High	High		

Subgroup **10.9**

Forged austenitic nozzles
Alloy 600, PWR primary water
653°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RPV
28,29,30

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Forged alloy 600 SCC a generic problem.	Time, temperature and material susceptibility.
2	High	High	Medium	Generic issue for nickel base alloys.	Insufficient understanding of problem, and need for development of inspection and prediction tools
3	High	High	High	The fact that Alloy 600 sustains SCC is a clear indication that the this alloy at any thickness is prone to SCC. Residual stresses will always be present. Ripple loading will accentuate this SCC and should be carefully assessed for the extent of such loading.	These locations should be frequently inspected
4	High	High	Medium	Forged alloy 600 SCC a generic problem	Time, temperature and material susceptibility in case of nickel alloys only.
5	Low	High	High	Needs high stresses or cold work, plus corrosive contamination	
6	High	High	Medium	SCC of forged alloy 600 is a generic (and rather unpredictable) problem	Initiation time in PWR primary water is long and unpredictable. Temperature plus materials variables appear be key determinants.
7	High	High	Medium	Forged alloy 600 SCC a generic problem - not an issue for stainless steels	Time, temperature and material susceptibility in case of nickel alloys only.
8	High	High	Medium	Forged alloy 600 SCC a generic problem - not an issue for stainless steels	Time, temperature and material susceptibility in case of nickel alloys only.

Subgroup
10.10

CRDM Housing and canopy SS seals
Type 304, 308, PWR Primary water
200°F to 600°F, 2250 psia (normally stagnant)

Applies to BNL Part #s with prefix RCS-RPV
32

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not a known generic problem leading to significant material wastage despite examples of non-standard chemistry in deadlegs. Oxygen is only present transiently after refueling and during this period small pits may form and initiate SCC.	Presence of oxygen and substantial chloride concentration.
2	Medium	High	High	potential problem in stagnant conditions containing oxygen	
3	Low	Medium	Medium	Crevice corrosion per se should not be a major corrosion problem except as the presence of crevices may stimulate SCC or pitting that activates corrosion fatigue. Such crevices would also be pertinent at shutdowns if oxygen is in the system.	Contributes to conditions and local corrosion that accerate corrosion fatigue and SCC.
4	Low	Medium	Medium	Possible in principle because of O2 inclusion following shutdown. Not a common observed degradation mechanism	
5	Low	High	High	possible if deposits or crevices present, especially at lower temperatures	
6	Medium	Medium	Low	Crevice attack of stainless steels probably is possible in this region of the vessel (where the chemistry can be quite abnormal) and may have occurred in service	Not aware of any qualified mitigating actions
7	Low	High	High	Potential problem when oxygen introduced in the system.	Potential excursion.
8	Low	Medium	Medium		

Subgroup
10.10

CRDM Housing and canopy SS seals
Type 304, 308, PWR Primary water
200°F to 600°F, 2250 psia (normally stagnant)

Applies to BNL Part #s with prefix RCS-RPV
32

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Canopy seal failures are not generally thought to be due to corrosion fatigue but a fatigue element has been cited for some CE housing failures.	Environmental effects on fatigue cannot be discounted, especially at high R ratio (due to residual stress from welding).
2	Medium	High	Medium	Probable thermal fatigue issues	
3	Low	Medium	Medium	Stainless steel has worked well. The major question is time and the interaction of SCC and corrosion fatigue. The sources of cyclic stresses are not clear.	Pits formed in crevices
4	Low	High	Medium	No known incidences. Hard to define where cyclic loading coming from	
5	Low	High	High	needs high cyclic stresses plus corrosive environment	
6	Medium	Medium	Low	Corrosion fatigue of stainless steels probably is possible in this region of the vessel (where the chemistry can be quite abnormal) and may have occurred in service	Not aware of any qualified mitigating actions
7	Low	High	High	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Medium	High	Medium	Various conditions (O2) and stagnant	

Subgroup **10.10**

CRDM Housing and canopy SS seals
Type 304, 308, PWR Primary water
200°F to 600°F, 2250 psia (normally stagnant)

Applies to BNL Part #s with prefix RCS-RPV
32

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Canopy seal TGSCC is a generic problem due to non-standard water chemistry in dead legs. Cracking of CRDM housings is not a generic issue except in some CE plants where several incidents have occurred associated with welds.	Presence of pollutants such as chloride and sulfide and oxygen plus significant residual stress and cold work.
2	High	High	High	Good field experience to date, however sensitized 304 has been reported with SCC here where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Medium	The SS in the long term with high residual stresses and relatively long times may sustain SCC. The INSS data suggest this. The matter of SCC of SS needs more investigation. The SCC of SS does not seem as pressing as 600. However, we are talking about long times. It is my impression that the canopy seals are heavily cold worked . Cold work in general for the stainless steel may be an important contributor to SCC. It is also my impression that oxygen can accumulate in these locations.	Long times, cold work, ripple loading
4	Medium	High	Medium	SCC has occurred following occlusion of O2 in dead legs after shutdowns. Known superable problem	
5	Low	High	High	needs buildup of corrosive species and high stress/cold work	
6	Medium	Medium	Low	SCC of stainless steels probably is possible in this region of the vessel (where the chemistry can be quite abnormal) and may have occurred in service.	Not aware of any qualified mitigating actions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Medium	High	Medium	Various conditions (O2) and stagnant	

Subgroup **10.11** Dissimilar metal welds
Type 308, 309
External surface

Applies to BNL Part #s with prefix RCS-RPV
8,9
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen.	Hydrogenated promary water ensuring no dissolved oxygen
4	Low	High	High	Transgranular SCC possible if the external environment is wet and chloride contaminated. Susceptibility of duplex steels less than austenitic StSt.	
5	Low	High	High	unlikley that external environment could be sufficiently contaminated to be a concern; area needs to be wet some of the time	
6	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	RPV dissimilar metal welds vulnerable to wetting during refueling. This cracking can also occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	Low	Medium	Medium	Need more characterization of SCC behavior of these alloys under Cl contaminated condition	Contamoination by insulators and air with Cl
8	Low	High	High		

Subgroup **10.12** Dissimilar metal welds
Alloys 82, 182
External surface

Applies to BNL Part #s with prefix RCS-RPV
8,9
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization but less so than in stainless steel case.	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization.	This cracking can ossur prior to service during stress relief or due to exposure to salt atmospheres.
4	Low	High	High	Transgranular SCC possible if the external environment is wet and chloride contaminated. Susceptibility of 82/182 less than austenitic StSt.	
5	Low	High	High	unlikley that external environment could be sufficiently contaminated to be a concern; area needs to be wet some of the time	
6	Low	Medium	Medium	Known issue in dilution zone with low alloy steel - sensitization. Less susceptible than 309/309 DM welds	RPV dissimilar metal welds vulnerable to wetting during refuelling. This cracking can also occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	Low	Medium	Medium	Need more characterization of SCC behavior of these alloys under Cl contaminated condition	Contamoination by insulators and air with Cl
8	Low	High	High	Little concern for high Ni alloy, which are much more Cl resistant	

Subgroup **11.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **11.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **11.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2, SA-508 Cl.2A, SA-516
PWR primary water, 544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,21,22,56,57,58,59,60,62,63,64,66

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Boric acid corrosion of low alloy steels due to leaks from manway or drain line penetrations. More a problem for the SG supports, particularly the bearing surfaces.	Leaks at flanges or from SG channel head drain lines.
2	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
3	0	High	High	Not an issue on the secondary side	
4	Low	Medium	Medium	Only if have a leakage through the SG shell exposed to primary side environment. Seems unlikely	
5	Low	High	High	Very good field experience; needs leakage path to external to build up corrosive environment	
6	Low	Medium	Medium	External wastage due to primary side leakage	Primary side leak is required that wets external surface (which seems unlikely except for the bottom head/nozzles where leakage due to SCC of nickel-alloy nozzle-to-piping dissimilar metal welds might lead to leakage)
7	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Upper and lower heads are the most vulnerable close to nickel alloy penetrations that may leak. Leaks from the CRDM mechanism housings onto the upper head also pose a significant threat
8	Low	Medium	Medium		

Subgroup **11.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2, SA-508 Cl.2A, SA-516
PWR primary water, 544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,21,22,56,57,58,59,60,62,63,64,66

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Not normally exposed to primary water in the channel head but may be possible from drain line leaks. Also SG tube cracks can allow primary water to penetrate to the tube sheet. However, no active crevice corrosion due to absence of oxygen in primary water. No known secondary side crevice corrosion problems except those at carbon steel support plates -see 11.20	Not anticipated to be a problem due to negligible dissolved oxygen except possibly during shutdown.
2	Low	High	High	Not anticipted to be a problem due to absence of dissolved oxygen except during shutdown.	
4	Low	High	High	Criteria for crevice corrosion not met given these components are in deoxygenated environment and are not heat transfer surfaces.	
5	Low	High	High	Does not seem likely at normal operating conditions; possible at shutdowns especially if oxidizing conditions could exist and any corrosive impurities introduced (sulfides, chlorides)	
6	Low	Medium	High	Probably possible in unclad areas. May require the presence of an oxidant (e.g., copper)	Shouldn't be a significant problem if chemistry is maintained within Guideline limits
7	Low	High	High	Crevice formation is likely and potential problem.	Crevice formation
8	Low	High	High		

Subgroup **11.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2, SA-508 Cl.2A, SA-516
PWR primary water, 544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,21,22,56,57,58,59,60,62,63,64,66

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FAC of carbon steel items is always possible (especially tube support plates - see 11,20) but not an issue so far for low alloy steels. Big differences in field experience depending on secondary water chemistry.	Secondary water chemistry. Seawater ingress at condenser probably aggravates FAC. Some amines appear to offer good protection.
2	0	High	Medium	Do not consider an issue for these components	
3	0	Medium	Medium	Little if any BAC on the secondary side of SG nor on the primary side.	
4	0	High	High	Unlikely to be a problem with SG shell. Possible problem with carbon-steel support sheets if corrosion potential too low	
5	Low	High	High	FAC if chemistry too reducing and where high flows occur	
6	Low	Medium	High	Field experience in unclad SGs	Shouldn't be a problem in clad SGs unless there is a break in the cladding
7	High	Medium	Medium	Depend upon the flow pattern and likely various location.	velocity and material
8	Low	Medium	Medium	Not clear why FAC should be a problem in plates, shells …	

Subgroup **11.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2, SA-508 Cl.2A, SA-516
PWR primary water, 544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,21,22,56,57,58,59,60,62,63,64,66

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Difficult to distinguish from SCC. Good field experience although some failures of secondary side shell due to unusually high residual welding stresses at the upper cone transition weld and oxygen/copper ion ingress.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head or on secondary water side of SG shell in event of oxygen and/or copper ion ingress
2	Low	High	High	Only an issue under very specific loading conditions	
3	Low	Medium	Medium	Corrosion fatigue is connected with SCC	Mostly for
4	Low	High	High	Good field experience although some failures of secondary side shell due to unusually high residual welding stresses at the upper cone transition weld and oxygen/copper ion ingress.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head or on secondary water side of SG shell in event of oxygen and/or copper ion ingress
5	Low	High	High	Very good field experience	
6	Low	High	High	Good field experience although some failures of secondary side shell due to unusually high residual welding stresses at the upper cone transition weld and oxygen/copper ion ingress.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head or on secondary water side of SG shell in event of oxygen and/or copper ion ingress
7	Low	High	High	Good field experience although some failures of secondary side shell due to unusually high residual welding stresses at the upper cone transition weld and oxygen/copper ion ingress.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head or on secondary water side of SG shell in event of oxygen and/or copper ion ingress
8	Low	High	High	Good field experience although some failures of secondary side shell due to unusually high residual welding stresses at the upper cone transition weld and oxygen/copper ion ingress.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head or on secondary water side of SG shell in event of oxygen and/or copper ion ingress

Subgroup **11.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2, SA-508 Cl.2A, SA-516
PWR primary water, 544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,21,22,56,57,58,59,60,62,63,64,66

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Almost certain to occur on secondary side since oxygen transients are unlikely to be totally eliminated. Depth limited.	Oxygen plus condenser leaks, especially seawater.
2	0	High	Medium	only theoretical problem if cladding penetrated	
3	Low	High	High	Pitting occurs during shutdown when oxygen is present. The pitting can be related to SCC as an initiation site	
4	Low	Medium	Low	Pitting of carbon steel supports sheets possible during shutdown which might, under dynamic loading conditions lead to SCC under full load conditions. Hard to see how this would affect integrity of pressure boundary tubes.	
5	Low	High	High	could occur at shutdown if water aerated	
6	Low	Medium	Medium	Pitting has been observed in unclad areas. Probably associated with presence of oxidant (e.g., copper)	Shouldn't be a problem if chemistry is maintained within Guideline limits
7	Low	Medium	Medium	Potential problem with oxygen addition.	Potential.
8	Low	High	Medium		

Subgroup **11.2**

Shell plates/forgings/welds/brackets etc
A533 Gr.A Cl.2, SA-508 Cl.2A, SA-516
PWR primary water, 544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,21,22,56,57,58,59,60,62,63,64,66

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Difficult to distinguish from corrosion fatigue. Good field experience although some failures of secondary side shell due to unusually high residual welding stresses at the upper cone transition weld and oxygen/copper ion ingress.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head or on secondary water side of SG shell in event of oxygen and/or copper ion ingress
2	0	High	Medium	only theoretical problem if cladding penetrated	
3	Low	Medium	Medium	SCC has occurred in several SGs at the girth weld. This seemed related to pits produced during shutdowns in several plants. A detailed report was written. SCC related also to some Cu transport.	
4	Medium	High	Medium	SCC/corrosion fatigue has occurred on secondary side SG shell (Indian point -2) due to presence of Cu cation oxidizing impurity.(see reference to corrosion fatigue above) This is an understandable condition, but it is unclear that the current PWR WC guidelines adequately addresses this particular operating mode and degradation mechanism.	
5	Low	High	High	could occur at shutdown if water aerated	
6	Low	Medium	Medium	Generally good field experience but SCC is possible under faulted (oxidizing) chemistry conditions	Initiation appears to require oxidizing conditions and is not likely in clad regions unless there is a break in the clad
7	Low	High	High	Very unlikely based upon Lab. Data so far.	Any hardening possible?
8	Low	High	High	Concern primarily for off-chemistry conditions.	

Subgroup **11.3**

Low alloy steel nozzles/welds
SA-216 Gr. WCC, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
19,20

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	Medium	Difficult to see how concentrated primary water could come into contact with the nozzles and welds	
2	0	High	Medium	Not an issue from inside the component	
3	0	High	High	not a problem on the secondary side	
4	Low	Medium	Medium	Only if have a leakage through the SG shell exposed to primary side environment. Seems unlikely	
5	Low	High	High	Very good field experience; needs leakage path to external to build up corrosive environment	
6	Low	Medium	Medium	External wastage due to primary side leakage	Primary side leak is required that wets external surface (which seems unlikely except for the bottom head/nozzles where leakage due to SCC of nickel-alloy nozzle-to-piping dissimilar metal welds might lead to leakage)
7	Medium	High	Medium	Boric acid corrosion of low alloy steels due to leaks	Dissimilar weld joint are the most vulnerable close to nickel alloy and stainless steels.
8	Low	Medium	Medium	Concern for boric acid leaks.	

Subgroup **11.3**

Low alloy steel nozzles/welds
SA-216 Gr. WCC, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
19,20

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Not exposed to primary water in the channel head plus absence of oxygen. Possible for carbon steel components on secondary side in secondary side crevices in presence of acidic pollutants.	Would require prior cladding failure and presence of dissolved oxygen on primary side. Condenser leaks (of seawater) on secondary side. Resin ingress.
2	Low	High	High	Concern for upset chemistry conditions and if crevice present	
3	0	Medium	Medium	Not sure where the crevice comes from	
4	0	High	High	Hard to visualize electrochemical conditions that would give rise to crevice corrosion	
5	Low	High	High	could occur at shutdown if water aerated and deposits crevices present	
6	Low	Medium	Medium	Probably possible in unclad areas. May require the presence of an oxidant (e.g., copper)	Shouldn't be a significant problem if chemistry is maintained within Guideline limits
7	Low	High	High	Very unlikely based upon potential.	
8	Low	Medium	Medium		

Subgroup
11.3

Low alloy steel nozzles/welds
SA-216 Gr. WCC, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
19,20

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FAC of carbon steel items is always possible (especially tube support plates - see 11,20) but not an issue so far for low alloy steels. Big differences in field experience depending on secondary water chemistry.	Secondary water chemistry. Seawater ingress at condenser probably aggravates FAC. Some amines appear to offer good protection.
2	0	High	Medium	Do not consider an issue for these components	
3	0	Medium	Medium	Little if any BAC on the secondary side of SG nor on the primary side.	
4	0	High	High	Unlikely to be a problem with SG shell. Possible problem with carbon-steel support sheets if corrosion potential too low	
5	Low	High	High	FAC if chemistry too reducing and where high flows occur	
6	Low	Medium	High	Field experience in unclad SGs	Shouldn't be a problem in clad SGs unless there is a break in the cladding
7	High	Medium	Medium	Depend upon the flow pattern and likely various location.	velocity and material
8	Low	Medium	Medium	Not clear why FAC should be a problem in plates, shells …	

Subgroup **11.3**

Low alloy steel nozzles/welds
SA-216 Gr. WCC, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
19,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Difficult to distinguish from SCC. Very good field experience with channel head nozzles. Not so good with secondary water feed nozzles where cold and hot water stratification during hot standby has been a problem.	Potential risk of corrosion fatigue/SCC if cladding penetrated on primary side in channel head. No known recent corrosion fatigue incidents on secondary side so stratification problem presumably resolved by operational changes and installation of mixing devices.
2	Low	High	High	Only an issue under very specific loading conditions	
3	Low	Medium	Medium	These nozzles seem to sustain thermal fatigue due to stratification of water	need better flow mixing
4	Low	High	High	Very good field experience with channel head nozzles.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head
5	Low	High	High	Good field experience	
6	Low	High	High	Very good field experience with channel head nozzles.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head
7	Low	High	High	Very good field experience with channel head nozzles.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head
8	Low	High	High	Very good field experience with channel head nozzles.	Potential risk of corrosion fatigue/SCC if cladding penetrated in channel head

Subgroup
11.3

Low alloy steel nozzles/welds
SA-216 Gr. WCC, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
19,20

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Almost certain to occur on secondary side since oxygen transients are unlikely to be totally eliminated. Depth limited.	Oxygen plus condenser leaks, especially seawater.
2	0	High	Medium	only theoretical problem if cladding penetrated	
3	Low	High	High	Pitting occurs during shutdown when oxygen is present. The pitting can be related to SCC as an initiation site	
4	Low	Medium	Low	Pitting of carbon steel supports sheets possible during shutdown which might, under dynamic loading conditions lead to SCC under full load conditions. Hard to see how this would affect integrity of pressure boundary tubes.	
5	Low	High	High	could occur at shutdown if water aerated	
6	Low	Medium	Medium	Pitting has been observed in unclad areas. Probably associated with presence of oxidant (e.g., copper)	Shouldn't be a problem if chemistry is maintained within Guideline limits
7	Low	Medium	Medium	Potential problem with oxygen addition.	Potential.
8	Low	High	Medium		

Subgroup **11.3**

Low alloy steel nozzles/welds
SA-216 Gr. WCC, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
19,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Difficult to distinguish from corrosion fatigue. Very good field experience with channel head nozzles. Not so good with secondary water feed nozzles where cold and hot water stratification during hot standby has been a problem.	Potential risk of corrosion fatigue/SCC if cladding penetrated on primary side in channel head. No known recent corrosion fatigue incidents on secondary side so stratification problem presumably resolved by operational changes and installation of mixing devices.
2	Low	High	High	Concern for upset chemistry conditions	
3	Low	Medium	Medium	These steels sustain SCC usually at more oxygenated potentials	
4	Medium	High	Medium	Only possible if have dynamic loading plus oxidizing impurities on secondary side	
5	Low	High	High	could occur at shutdown if water aerated	
6	Low	Medium	Medium	Generally good field experience but SCC is possible under faulted (oxidizing) chemistry conditions	Initiation appears to require oxidizing conditions and is not likely in clad regions unless there is a break in the clad
7	Low	High	High	Very unlikely based upon Lab. Data so far.	Any hardening possible?
8	Low	Medium	Medium	Concern primarily for off-chemistry conditions.	

Subgroup **11.4**

Stainless cladding - Channel head
Types 308, 309, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fabrication issue for which the precursors are now well understood and avoided. No obvious mechanism for growth except fatigue.	Fabrication issue
2	0	High	Medium	not a degradation issue, could provide crevice conditions	
3	Low	High	High	Debonding is rarely if ever observed. However, long times with many shutdowns might lead to some debonding	
4	Low	High	High		
5	Low	High	High	unlikely; good field experience	
6	Low	Medium	Medium	Has occurred occasionally in the field	Susceptibility depends on the details of the cladding process
7	Medium	High	High		
8	Low	Medium	Medium		

Subgroup
11.4

Stainless cladding - Channel head
Types 308, 309, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience but channel head/divider plate/tube sheet triple point a potentially fatigue sensitive area.	Hot cracking a potential issue (starter hot cracks for fatigue) - current CUFs not available to enable a more informed judgement
2	Low	Low	Low	Lab data limited, cladding not credited for structural integrity	
3	Low	Medium	Medium	Only a long term process of heating and cooling could produce a debond through fatigue based on the differences between the thermal expansivities. There does not seem to be a basis for corrosion fatigue except for the differential expansivities	
4	Medium	High	High	Good field experience but channel head/divider plate/tube sheet triple point a potentially fatigue sensitive area.	Hot cracking a potential issue (starter hot cracks for fatigue) - current CUFs not available to enable a more informed judgement
5	Low	High	High	Good field experience - hot cracks in alloy 82 could pose problems	
6	Medium	High	High	Good field experience but channel head/divider plate/tube sheet triple point a potentially fatigue sensitive area.	Hot cracking a potential issue (starter hot cracks for fatigue) - current CUFs not available to enable a more informed judgement
7	Medium	High	High	Good field experience but channel head/divider plate/tube sheet triple point a potentially fatigue sensitive area.	Hot cracking a potential issue (starter hot cracks for fatigue) - current CUFs not available to enable a more informed judgment
8	Medium	High	High	Good field experience but channel head/divider plate/tube sheet triple point a potentially fatigue sensitive area.	Hot cracking a potential issue (starter hot cracks for fatigue) - current CUFs not available to enable a more informed judgement

Subgroup **11.4**

Stainless cladding - Channel head
Types 308, 309, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld deposits susceptible to thermal aging but less so than in cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Martensite phase at low alloy steel interface due to excessive weld heat input can and has cracked - fabrication issue	Known issue. Effective prediction models for austeno-ferritic weld deposits.
2	0	High	Medium	cladding not credited for structural integrity	
3	0	High	High	Fracture resistance seems out of place here	
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA) including delta ferrite embrittlement.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Effect of aged ferrite and in-situ FR test unclear	

Subgroup
11.4

Stainless cladding - Channel head
Types 308, 309, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Unknown on primary side except for dissolution of surface breaking slag inclusions. Consistent with fundamental understanding of pitting.	
2	0	High	Medium	possible in connection with debonding	
3	Low	High	High	Pitting is not a viable process at operating temperatures. With shutdowns and oxygen intrusions, pitting would do little damage unless as a site for initiating corrosion fatigue.	
4	Low	High	High	Only possible at these nominally low potentials under somewhat unusual impurity conditions plus very narrow potential range for "active" pitting	
5	Low	High	High	could occur at shutdown if water aerated	
6	Low	Medium	Medium	Hasn't been a major concern to date (except as a potential initiator of EAC)	More likely to be a significant issue if the chemistry gets seriously out-of-whack
7	Low	Medium	Medium	Potential problem with oxygen addition.	Potential.
8	Low	High	High		

Subgroup **11.4**

Stainless cladding - Channel head
Types 308, 309, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good field experience. Underclad cracks a fabrication issue.	No problems anticipated in normal PWR primary water with negligible oxygen. Excessive dilution of stainless clad may give potentially susceptible microstructure
2	Low	High	Low	Known issue in dilution zone with low alloy steel sensitization	
3	Low	Medium	Medium	SCC unlikely in view of good performance of other SS. The SS is in compression and would further diminish the tendency for SCC	
4	Medium	High	High	Good field experience for S/S, a few problems with Alloy 82, no known problems with alloy 52	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water
5	Low	High	High	Good field experience for S/S, some problems with Alloy 82	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	High	High	Good field experience for S/S, a few problems with Alloy 82, no known problems with alloy 52	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water
8	Medium	High	High	Good field experience for S/S, a few problems with Alloy 82, no known problems with alloy 52	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water

Subgroup
11.5

SG tubes/roll transitions/U-bends/sleeves/plugs
Alloy 600 MA, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
23,24,25,26,27,28,29,30,31,33,68

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves or between cracked tubes and tube sheet. Possible vibration issues and high cycle fatigue but incidence very low.	High cycle fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
2	Medium	Medium	Medium		
3	Medium	Medium	Medium	The extent to which corrosion fatigue is important relative to SCC is not clear. It is likely that SCC is accelerated by ripple loading.	Possibly high velocity flow induced vibration. There seems less possibility for low cycle fatigue except for the startup process where the tube sheet bows upward and places a bending stress on the tubes. This is low cycle fatigue but could be important in the long term.
4	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
5	Low	Medium	Low	Tube deformation due to diode effect at sleeves	
6	Low	Medium	Medium	Potential vulnerability but not much field experience	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness
7	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms

Subgroup
11.5

SG tubes/roll transitions/U-bends/sleeves/plugs
Alloy 600 MA, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
23,24,25,26,27,28,29,30,31,33,68

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Known issue with alloy 600 MA when subject to plastic deformation and cold work	Alloy 600 MA generically susceptible depending on stress level and extent of cold work.
2	High	High	High	well characterized phenomenon	
3	High	High	High	The SCC of Alloy 600 on the primary side is well known.	Use of Alloy 600
4	Medium	High	Medium	Known issue	
5	Medium	High	Low	Known issue even with alloy 600 TT subject to high deformation	
6	Medium	High	High	Well-known generic issue with alloy 600MA when subject to high deformation and cold work	Alloy 600MA is susceptible depending on stress level and extent of cold work.
7	Medium	High	High	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
8	High	High	Medium	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.

Subgroup
11.6

SG tubes secondary side including crevices
Alloy 600 MA, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
23,24,25,26,27,28,29,30,31,33,68

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	A few known cases but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
2	Medium	High	High	well characterized phenomenon	
3	Low	Medium	Medium	Corrosion fatigue is related to the ripple on the SCC but seems also to be high cycle from vibration and thus functions mostly as a fatigue input.	SCC is the major problem
4	Low	High	High	A few known cases but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
5	Low	High	High	Usually depends on prior damage due to corrosion mechanisms	
6	Low	Medium	Medium	A few known cases but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
7	Medium	Medium	Medium	A few known cases but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	Medium	Medium	A few known cases but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms

Subgroup
11.6

SG tubes secondary side including crevices
Alloy 600 MA, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
23,24,25,26,27,28,29,30,31,33,68

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	An old problem from the days of widespread condenser leakage unlikely to be repeated.	Condenser leakage
2	Low	High	High	in connection with crevices	
3	Low	High	High	No longer an issue	
4	Low	High	High	Known issue in sludge piles, associated with oxygen transients	
5	Low	High	High	could occur at shutdown if water aerated	
6	Low	High	Medium	Pitting has occurred in sludge piles apparently under oxidizing conditions during shutdowns	Ingress of oxygen should be avoided
7	Low	Medium	Medium	Potential problem with oxygen addition.	Potential.
8	Low	Medium	High		

Subgroup **11.6**

SG tubes secondary side including crevices
Alloy 600 MA, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
23,24,25,26,27,28,29,30,31,33,68

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Generic issue for alloy 600 MA but most potentially susceptible tube bundles rapidly disappearing from service.	Impurity hideout usually considered a precursor in fouled circular drilled crevices and at contact lands in broached support plate holes. However, the diffusion distance for hydrogen from the primary side is shorter than its escape route from fouled secondary side crevices; thus risk of primary side type cracking on secondary side also possible.
2	High	High	High	well characterized phenomenon	
3	High	High	High	The SCC of Alloy 600 on the secondary side is well known although the details of how the SCC occurs are not. Possibility of major failures due to presence of Pb should be considered.	High residual stresses and Alloy 600
4	High	High	Medium	Known problem with 600MA to date, and expect problem to extend to alloy 600 TT. Lower knowledge value than 2 may be appropriate given difficulty in defining environmental system	No known issues with alloy 690 (components 25 and 49) except for Pb.
5	High	High	High	Known issue	
6	High	High	Medium	Generic issue for Alloy 600MA tubes. Has been responsible for the majority of tube pluggings during the past decade	No fully effective chemistry mitigation actions have been qualified to date
7	High	Medium	Medium	Known issue	
8	High	High	Medium	Known issue	

Subgroup
11.6

SG tubes secondary side including crevices
Alloy 600 MA, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
23,24,25,26,27,28,29,30,31,33,68

Notes:

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
2	Medium	High	Medium	known problem	
3	High	High	High	The wear of SG tubes in the U bend region is well known and is partly handled by design of the antivibration bars. No major penetrations for large number of bars.	Design problem
4	Medium	High	Medium	Anti-vibration bars - known issue - depends on design and as-built clearances	
5	Medium	High	High	Anti-vibration bars - known issue - depends on design and as-built clearances	
6	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
7	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
8	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances

Subgroup
11.7

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
7	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.
8	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects. Good field experience so far.	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup
11.7

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld deposits susceptible to thermal aging but less so than in cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Martensite phase at low alloy steel interface due to excessive weld heat input can and has cracked - fabrication issue	Known issue. Effective prediction models for austeno-ferritic weld deposits.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA) including delta ferrite embrittlement.	LTA and hardening can cause SCC under some certain condition
8	Medium	High	Low	Effect of aged ferrite and in-situ FR test unclear.	

Subgroup **11.7**

Dissimilar metal welds (Internal)
Type 308, 309, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Any sensitized material in dilution zone should not be a problem in absence of dissolved oxygen	Hydrogenated primary water ensuring no dissolved oxygen.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
5	Medium	High	Low	Known issue in dilution zone with welds to low alloy steel - sensitization	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic weld metals due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.

Subgroup
11.8

Forged austenitic nozzles
Type 316, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought austenitic materials applies.	Surface finish a known influencing factor. Only likely to be a problem where present nominal CUF>0.1approx.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Surface finish a known influencing factor
5	Medium	Medium	Medium	Surface finish and cold work a known problem	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in service	Surface finish a known influencing factor
8	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in service	Surface finish a known influencing factor

Subgroup **11.8**

Forged austenitic nozzles
Type 316, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	
2	Low	Medium	Medium	Good field experience, but long initiation times and effects of grinding cannot be ignored.	
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
5	Low	High	High	needs high stresses	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	Medium	Medium		

Subgroup **11.9**

Channel head divider plate
Alloy 600, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
65
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible corrosion fatigue	Adjacent weld, especially at triple point likely to be more susceptible in service.
2	Medium	Medium	Medium	thermal differential across component could provide adverse loading conditions	
3	Medium	High	High	Corrosion fatigue will probably be part of the SCC issue as a contribution through ripple loading. Any flow effects are most likely high frequency.	Mostly related to SCC
4	Low	Medium	Low	Possible corrosion fatigue	Adjacent weld, especially at triple point likely to be more susceptible in service.
5	Low	Medium	Low	Possible corrosion fatigue	
6	Low	Medium	Medium	Possible corrosion fatigue	Adjacent weld, especially at triple point likely to be more susceptible in service.
7	Low	Medium	Medium	Possible corrosion fatigue	Adjacent weld, especially at triple point likely to be more susceptible in service.
8	Low	Medium	Medium	Possible corrosion fatigue	Adjacent weld, especially at triple point likely to be more susceptible in service.

Subgroup **11.9**

Channel head divider plate
Alloy 600, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue with forged alloy 600 when subject to plastic deformation and cold work although only one known incident to date.	Potential generic susceptibility in PWR primary water depending on stress level and extent of cold work.
2	High	High	High	generic issue	
3	High	High	High	Anything fabricated of Alloy 600 will eventually SCC; thick sections will take longer. All of these parts have high residual stresses	Residual stresses
4	Medium	High	Medium	Possible generic issue with forged alloy 600 when subject to high deformation and cold work at triple point .	Generic susceptibility depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
5	Medium	Medium	Low	Known issue for alloy 600 only	
6	Medium	High	Medium	Known issue with forged alloy 600 when subject to high deformation and cold work although only one known failure to date.	Generic susceptibility depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
7	Medium	High	Medium	Known issue with forged alloy 600 when subject to high deformation and cold work although only one known incident to date.	Generic susceptibility depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
8	Medium	High	Medium	Known issue with forged alloy 600 when subject to high deformation and cold work although only one known incident to date.	Generic susceptibility depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.

Subgroup
11.10

Primary and Secondary Manways
SA-553 Gr. A, Containment air
In the event of flange leak
544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
66,67
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue	Always possible if flange leaks
2	Medium	High	Medium	only in the event of flange leak	
3	Low	Medium	Medium	I am not are of any such corrosion in this application although it could occur.	
4	Medium	Medium	Medium	Always possible if flange leaks. BAC management programs in place; knowledge value probably adequate for this particular component	Retaining bolts/studs not listed separately
5	Low	Medium	High	Always possible if flange leaks	
6	Medium	Medium	Medium	Well-known issue	Always possible if flange leaks
7	Medium	Medium	Medium	Known issue	Always possible if flange leaks
8	Medium	Medium	Medium	Known issue	Always possible if flange leaks

Subgroup
11.10

Primary and Secondary Manways
SA-553 Gr. A, Containment air
In the event of flange leak
544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
66,67
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
2	Low	High	High	Only an issue under very specific loading conditions, not likely here	
3	Low	Medium	Medium	Not aware of any failure of any kind including corrosion fatigue	
4	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	Good service experience to date but CUFs not available.
5	Low	Medium	Medium	No known fatigue issues but must be a potential degradation mode	
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
7	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.

Subgroup
11.10

Primary and Secondary Manways
SA-553 Gr. A, Containment air
In the event of flange leak
544°F to 620°F, 1000 or 2250 psia

Applies to BNL Part #s with prefix RCS-SG
66,67
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	Low	High	High	concern in upset chemistry conditions	
3	Low	Medium	Medium	These steels sustain SCC at these temperatures but usually at higher potentials than PWR deaearated systems.	Oxidizing conditions required for SCC at temperature not probable
4	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
5	Low	High	High	needs high stresses	
6	Low	High	Medium	Has occurred but not since molybdenum disulfide lubricants were banned	Not considered a significant future threat.
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.

Subgroup
11.11

Stainless cladding - Channel head
Alloys 82, 52, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known fabrication issue at tube seal welds. Only fatigue is a credible growth mechanism. Also hot cracking, which is more of a problem with alloy 52.	Underclad cracks not exposed to primary or secondary water.
2	0	High	High	Fabrication issue. Good experience.	
4	Low	High	High	Phenomenum observed relatively early in LWR history, which has been resolved via tighter fabrication specifications	
5	Low	High	High	unlikely except at sites of poor adhesion (fabrication) or where the cladding has been damaged/penetrated by mechanical action.	
6	Medium	Medium	High	Probably more likely for Alloy 52 which has some weldability problems	Depends on details of the fabrication process. Note that cracks are not exposed to coolant
7	Low	High	High	Theoretical concern and unlikely in the plants	Bond strength and a formation of embrittled phase.
8	Low	High	High		

Subgroup
11.11

Stainless cladding - Channel head
Alloys 82, 52, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fully austenitic - toughness not an issue	
2	0	High	Medium	Not an issue, cladding not credited for structural integrity	
3	0	High	High	This is not a fracture resistance issue since it is a cladding on a larger substrate.	
4	Medium	High	Low	Potential LTCP embrittlement for the high chromium nickel base welds in primary environment under specific loading/temperature conditions during shutdown	
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals	It's not clear if the conditions required for LTCP in lab tests are met in PWR service. The likelihood appears greatest during cooldown.
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA) including delta ferrite embrittlement. EAC-induced FR reduction would be very likely.	LTA and hardening can cause SCC under some certain condition
8	Medium	Medium	Medium	Effect of in-situ FR testing unclear	

Subgroup
11.11

Stainless cladding - Channel head
Alloys 82, 52, PWR primary water
610°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
60,64,66

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Potential generic susceptibility of alloy 82 cladding but no known incidents except where cold worked by loose parts.	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water
2	Low	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
3	Low	Medium	Medium	SCC occurs in Alloy 600 and 52; the stresses in the cladding will be compressive at the interface of the bond and probably continue to be somewhat compressive at the surface. Residual stresses may be more dominant in producing SCC	Some SCC is possible and would make the steel substrate accessible. Some corrosion-produced debonding should be considered.
4	Medium	High	High	Good field experience for S/S, a few problems with Alloy 82, no known problems with alloy 52	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water
5	Low	High	High	Good field experience for S/S, some problems with Alloy 82	
6	Medium	High	High	A few problems with Alloy 82, no known problems with Alloy 52. Well-known vulnerability for Alloy 600, if exposed	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water
7	Medium	High	High	Good field experience for S/S, a few problems with Alloy 82, no known problems with alloy 52	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water
8	Medium	High	High	Good field experience for S/S, a few problems with Alloy 82, no known problems with alloy 52	Potential generic sensitivity of alloy 82 cladding to IGSCC in primary water

Subgroup
11.12

SG tubes/roll transitions/U-bends/sleeves/plugs
Alloy 600 TT, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
34,35,36,37,38,39,40,41,42,44,69

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	High cycle fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
2	Medium	High	High	well characterized phenomenon	
3	Low	Medium	Medium	Probably not a major concern	
4	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
5	Low	High	High	uncommon; needs high stresses; has been seen early in SG life; attributable to poor supports	
6	Low	Medium	Medium	Potential vulnerability but little field experience	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness
7	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms

Subgroup
11.12

SG tubes/roll transitions/U-bends/sleeves/plugs
Alloy 600 TT, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
34,35,36,37,38,39,40,41,42,44,69

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Known issue with alloy 600 TT when subject to plastic deformation and cold work although significantly less susceptible in general than alloy 600MA	Alloy 600 TT susceptible in PWR primary water depending on stress level and extent of cold work.
2	Medium	High	High	generic issue	
3	Medium	High	High	SCC in primary water for Alloy 600TT is less intense than for Alloy 600MA.	
4	Medium	Medium	Medium	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
5	High	High	High	well known issue	
6	Medium	High	Medium	Known issue for alloy 600 TT when subject to high deformation and cold work	Alloy 600TT generically susceptible depending on stress level and extent of cold work. Generally good field experience to date but at least one failure has occurred
7	Medium	High	High	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
8	High	High	Medium	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.

Subgroup
11.13

SG tubes/roll transitions/U-bends/sleeves/plugs
Alloy 690 TT, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
45,46,47,48,49,50,51,52,53,55,70

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Possible vibration issues and high cycle fatigue.	High cycle fatigue crack initiation depends on inadequate tube support
2	Low	High	High	should have been solved with improved design of replacement steam generators	
3	Low	Medium	Medium	Not a concern	Not a concern
4	Medium	Medium	Medium		
5	Low	High	High	unlikely; needs high cyclic stress and corrosive environment	
6	Low	Medium	Medium	Potential vulnerability but no field failures to date	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness
7	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	Medium	Medium	Tube deformation due to diode effect at sleeves. Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms

Subgroup
11.13

SG tubes/roll transitions/U-bends/sleeves/plugs
Alloy 690 TT, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
45,46,47,48,49,50,51,52,53,55,70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Extensive laboratory testing has shown alloy 690 to be highly resistant to IGSCC initiation in PWR primary water, even when subject to very high deformation and cold work. No reason to suspect a generic cracking issue.	Up to 15 years operating experience without any tube cracking.
2	Low	Medium	Low	Insufficient data and field experience	
3	Low	High	High	Good results in the field; some susceptibility with non-standard heat treatments and cold work	Non standard heat treatments; cold work abuse
4	Medium	High	Medium	Good experience so far, compared with 600MA and 600TT, but ,given the past surprises, unwilling to decrease the susc. score to 1 or 0	
5	Low	High	High	unlikely; lab data indicate very good resistance	
6	Low	High	High	Excellent field experience to date, in accordance with expectations based on lab testing	No problems anticipated for alloy 690 in PWR primary water.
7	Medium	High	High	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.
8	Medium	High	High	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work. No problems anticipated for alloy 690 in PWR primary water.

Subgroup
11.14

SG tubes secondary side including crevices
Alloy 600 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
34,35,36,37,38,39,40,41,42,44

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	A few known cases but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to secondary side corrosion mechanisms
2	Medium	High	High	well characterized phenomenon	
3	Low	Medium	Medium	Corrosion fatigue is related to the ripple on the SCC but seems also to be high cycle from vibration and thus functions mostly as a fatigue input.	
4	Low	High	High		
5	Low	High	High	some SGs seen this early in life; attributable to poor supports	
6	Low	Medium	Medium	A known vulnerability but no reason to suspect a widespread problem	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
7	Low	Medium	Medium	Vibration stress is critical depending upon flow induced vibration.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	High	High		

Subgroup
11.14

SG tubes secondary side including crevices
Alloy 600 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
34,35,36,37,38,39,40,41,42,44

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	An old problem from the days of widespread condenser leakage unlikely to be repeated.	Condenser leakage
2	Low	High	High	well characterized phenomenon	
3	Low	High	High	No longer an issue	
4	Low	High	High	Known issue in sludge piles, associated with oxygen transients	
5	Medium	High	High	well known, most likely at shutdown under aerated condition	
6	Low	High	Medium	Pitting probably is possible in sludge piles under oxidizing conditions during shutdowns	Ingress of oxygen should be avoided
7	Low	High	High	Well know issue in plants mostly in the past	Condenser leak
8	Low	High	Medium		

Subgroup
11.14

SG tubes secondary side including crevices
Alloy 600 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
34,35,36,37,38,39,40,41,42,44

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Secondary side IGA/IGSCC seems to be extending to Alloy 600TT, as expected, although most incidents to date have been linked to poor thermal treatment that failed to improve the grain boundary carbide structure relative to alloy 600MA.	Impurity hideout usually considered a precursor in fouled circular drilled crevices and at contact lands in broached support plate holes. However, the diffusion distance for hydrogen from the primary side may be shorter than its escape route from secondary side fouled crevices; thus risk of primary side type cracking on secondary side also possible.
2	Medium	High	High	generic issue	
3	Medium	Medium	Medium	The intensity of SCC of 600TT on the secondary is less than 600MA. Little occurrence of failure in the field. However, perhaps some will occur. Potential problem with Pb and low valence sulfur	
4	Medium	High	Medium	Improved resistance to 600MA	
5	High	High	High	well known issue	
6	Medium	High	Medium	Alloy 600TT is susceptible and at least one field failure (possibly Pb-related) has occurred	Cracking is likely eventually but timing is unpredictable. No fully effective chemistry mitigation actions have been qualified to date
7	High	High	Medium	Generic issue for alloys 600 with Pb etc	Residual stress and temperature
8	Medium	High	Medium		

Subgroup
11.14

SG tubes secondary side including crevices
Alloy 600 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
34,35,36,37,38,39,40,41,42,44

Notes:

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
2	Medium	High	Medium	known problem	
3	High	High	High	The wear of SG tubes in the U bend region is well known and is partly handled by design of the antivibration bars. No major penetrations for large number of bars.	Design problem
4	Medium	High	Medium	Anti-vibration bars - known issue - depends on design and as-built clearances, and should be independent of 600MA/600TT	
5	Medium	High	High	well known but caused by inadequate design of supports	
6	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
7	Medium	High	High	Well know issue in plants mostly in the past	Flow velocity and design
8	Medium	High	Medium		

Subgroup **11.15**

SG tubes secondary side including crevices
Alloy 690 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
45,46,47,48,49,50,51,52,53,55

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known cases and no reason to suspect a generic problem	Fatigue crack initiation depends on inadequate tube support
2	Low	High	High	should have been solved with improved design of replacement steam generators	
3	Low	Medium	Medium	Issue is mainly SCC	
4	Low	High	High		
5	Low	High	High	unlikely if supports well-designed	
6	Low	Medium	Medium	Excellent field experience to date	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
7	Medium	Medium	Medium	Vibration stress is critical depending upon flow induced vibration.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	High	Medium		

Subgroup **11.15**

SG tubes secondary side including crevices
Alloy 690 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
45,46,47,48,49,50,51,52,53,55

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	An old potential problem from the days of widespread condenser leakage unlikely to be repeated. Alloy 690 is also much more pitting resistant than Alloy 600.	Condenser leakage
2	Low	Medium	Low	Insufficient data and field experience	
3	Low	High	High	High Cr minimizes pitting	
4	Low	High	High		
5	Low	High	High	possible at shutdown if chemistry not well-controlled	
6	Low	Medium	Medium	Pitting may be possible in sludge piles under oxidizing conditions during shutdowns	Ingress of oxygen should be avoided
7	Low	High	High	Well know issue in plants mostly in the past	Condenser leak
8	Low	High	High		

Subgroup **11.15**

SG tubes secondary side including crevices
Alloy 690 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
45,46,47,48,49,50,51,52,53,55

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Laboratory testing has shown Alloy 690TT to be more resistant than Alloy 600 MA or TT in all the hypothesized concentrated solutions believed to accumulate in crevices by hideout, with the exception of those containing lead. Clearly future performance depends on control of impurity ingress, especially of lead.	Up to 15 years operating experience without problems to date. Improvements to the design of tube support plates (line rather than land contact at broached holes), improved cross flow over the tube sheet to minimize sludge deposition and much tighter secondary water chemistry control have all contributed to this improved performance.
2	Low	Medium	Low	Insufficient data and field experience	
3	Low	High	High	No failures to date in the field. Extensive SCC in Pb and reduced sulfur in the laboratory. SCC also in mild oxidizing acid environments. Increasing SCC in cold work.	Potential for SCC in Pb and S type concentrated environments.
4	Medium	High	Medium	690TT can still crack in secondary water albeit with increased resistance	No known issues with alloy 690 (components 25 and 49) except for Pb.
5	Low	High	High	possible with lead contamination; no field failures so far	
6	Low	Medium	Medium	Alloy 690 is vulnerable to Pb contamination and probably to other secondary side crevice environments. Cracking times are unpredictable (but apparently very long)	No fully effective chemistry mitigation actions have been qualified to date. Minimization of sludge deposition is highly desirable
7	Low	High	Medium	Generic issue for alloys 600 with Pb etc	Residual stress and temperature
8	Low	High	Medium		

Subgroup
11.15

SG tubes secondary side including crevices
Alloy 690 TT, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
45,46,47,48,49,50,51,52,53,55

Notes:

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
2	Low	High	Medium	should have been solved with improved design of replacement steam generators	
3	Low	Medium	Medium	Not aware of failures of 690 in wear mode	
4	Medium	High	Medium	Anti-vibration bars - known issue - depends on design and as-built clearances, and should be independent of 600MA/600TT	
5	Low	High	High	has occurred but related to support design and of limited extent so far	
6	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
7	Medium	Medium	Medium	Well know issue in plants mostly in the past	Flow velocity and design
8	Medium	Medium	Medium	Not sure if wear problems have been fixed	

Subgroup
11.16

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
2	Medium	Medium	Medium	Probable lack of data	
3	Medium	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where present nominal CUF>0.1approx.
5	Low	High	High	unlikely but possible if high cyclic stresses present	
6	Medium	Medium	Medium	Possible PWR primary water environmental effects	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Vibration stress is critical depending upon flow induced vibration.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	High	High		

Subgroup
11.16

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fully austenitic - toughness not an issue	
2	Low	High	Medium	Well characterized, but not in environment	
3	Medium	Medium	Medium	The existing Mills data show that the main loss of fracture resistance occurs at low temperate and that the 690 type is more prone to lose toughness than the 600. However, these patterns are not yet well defined. Nonetheless, careful attention should be given to operating conditions where the Alloy 600 base is exposed to lower temperatures and possibly some concern at higher temperatures	Lower temperatures more likely to produce lower fracture resistance for 600 base although greater degradation seems to occur in the 690 base
4	Medium	High	Low	There is a potential LTCP problem with these materials and also for replacement 52/152	The specific danger is dependent on the T/t transients and whether these can occur during normal or severe accident operation. This necessary knowledge does not currently exist.
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals	It's not clear if the conditions required for LTCP in lab tests are met in PWR service. The likelihood appears greatest during cooldown.
7	Medium	Medium	Medium	A kind of SCC phenomena and crack growth is subcritical. Not fracture toughness.	Loading rate.
8	Medium	High	Medium		

Subgroup **11.16**

Dissimilar metal welds (Internal)
Alloys 82, 182, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Generic issue for alloys 82/182 in PWR primary water.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.
2	High	High	Medium	Generic issue for alloys 82/182.	Insufficient understanding of problem, and need for development of inspection and prediction tools
3	High	High	High	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	High	High	Low	IGSCC in PWR primary water a generic issue for alloys 600/82/182 only. Lower value for "knowledge" reflects life management concerns following VC Summer hot leg and VHP incidents. We have poor predictive capabilities for e.g. composition effects and little assurance that mitigation actions associated with 690/152/52 will be fully effective. "Good" experience with replacement SG tubes not necessarily relevant. Poor specs for welding procedures for these high Cr alloys.	Problems anticipated after ~130,000 EFPhours exposure to PWR primary water.
5	Medium	High	High	sensitization a risk	
6	High	High	Medium	Generic issue for alloys 82/182	Long and very variable crack initiation times and unpredictable crack growth rates. No fully qualified chemistry mitigation actions available
7	High	High	Medium	Generic issue for alloys 82/182 only	Residual stress and temperature
8	High	High	Medium	Generic issue for alloys 82/182	Residual stress and temperature

Subgroup
11.17

Dissimilar metal welds
Type 308, 309
External surface

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Low	Medium	Low	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Low	cracking in external chloride contaminated environment less likely than for the 304 (see 11.1)	
5	Low	High	High	unlikely but possible if welds sensitized	
6	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	Medium	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Medium		

Subgroup
11.18

Dissimilar metal welds
Alloys 82, 182
External surface

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	High	Not an issue from external surface	
3	Low	Medium	Medium	External surfaces see almost no environment for CF; dry fatigue main concern. Defects in welds and abusive grinding possibly initiate mechanical fatigue	
4	Low	High	High	Fatigue is possible if component is vibtaing due to inadequate support. Environmnetal enhancement of fatigue also possible if the external environment is wet and chloride contaminated.However this enhancement for 82/182 will be less than austenitic StSt.	
5	Low	High	High	An issue only for components that can experience significant vibration.	
6	Low	Medium	Medium	Not seen in plants to date	Fatigue loads
7	Low	High	High	Contaminaion of external surface is critical.	Thermal fatigue is a source of cyclic stress
8	Low	High	High	Fatigue should affect hit internal of component before external	

Subgroup
11.18

Dissimilar metal welds
Alloys 82, 182
External surface

Applies to BNL Part #s with prefix RCS-SG
61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Known issue in dilution zone with low alloy steel leading to sensitization but less so than in stainless steel case.	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	0	High	Medium	Should not be an issue	
3	Low	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be more resistant than the Alloy 600 system. It's not clear that there are sufficient data to conclude that these weld metals will not sustain in the residual stresses and stress cycling to which they are exposed.	The necessary conditions for corrosion fatigue or SCC are not clear.
4	0	High	Medium	SCC due to Chloride not a problem with nickel base alloys	
5	Low	High	High	needs corrosive environment, e.g. moisture and/or deposits that can be wet	
6	Low	Low	Low	Don't know of any lab or field experience with this degradation mode	
7	Low	High	Medium	Need more data under Cl contaminated water. In general, unlikely	Residual stress and temperature
8	0	High	Medium	External (e.g., Cl) should not be an issue for high Ni 82/182	

Subgroup
11.19

Channel head divider plate
Alloy 690, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
65
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible corrosion fatigue	Adjacent weld, especially at triple point, may to be more susceptible in service.
2	Low	Medium	Medium	thermal differential across component could provide adverse loading conditions	
3	Low	Medium	Medium	The corrosion fatigue should be the ripple part of SCC acceleration. By itself it's probably not an issue	
4	Low	Medium	Low	Possible corrosion fatigue	
5	Low	High	High	unlikely; needs high cyclic stress; good field experience	
6	Low	Medium	Medium	Possible corrosion fatigue	Adjacent weld, especially at triple point likely to be more susceptible in service.
7	Low	Medium	Medium	Possible corrosion fatigue but very unlikely	Adjacent weld, especially at triple point likely to be more susceptible in service.
8	Medium	High	Medium		

Subgroup
11.19

Channel head divider plate
Alloy 690, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-SG
65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No problems anticipated for alloy 690 in PWR primary water as with SG tubes.	
2	Low	Medium	Low	Insufficient data and field experience	
3	Low	High	High	Alloy 690 should be good in this application. However, there is some concern about effects of cold work and high residual stresses. Also, heat treatments should be a larger and more variable problem for such plates since they are not made on a mass production basis.	Cold work and off heat treatment
4	Low	Medium	Medium	Susc. Score decreased to 1 compared with 600 (see11.9) but Confidence level score also decreased to 2.	
5	Low	High	High	unlikely; needs high stress; good field experience	
6	Low	High	Medium	Excellent field experience to date in accordance with expectations based on lab tests	No problems anticipated for alloy 690 in PWR primary water.
7	Low	Medium	Medium	Known issue with forged alloy 600 when subject to high deformation and cold work although only one known incident to date. Unlikely in 690	No problems anticipated for alloy 690 in PWR primary water.
8	Low	High	Medium		

Subgroup
11.20

Tube supports and/or preheater baffles
Carbon steel, drilled holes, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
71

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Crevice corrosion of carbon steel where hideout occurs is always possible. However, corrosion sufficient to cause denting of the tubes no longer appears to occur.	Greater attention paid to avoiding condenser leaks and to following good secondary water management.
2	Low	High	High	known issue	
3	High	High	High	Corrosion occurred in these crevices due to the concentration of species that resulted from superheat. The corrosion was not significantly due to the inherent crevice in the absence of superheat especially with no oxygen present.	not significant as a crevice but only due to superheat
4	Medium	Medium	Medium		
5	Medium	High	High	one of the causes of denting; copper and chlorides implicated	
6	Low	High	High	Well-known (and well-understood) issue underlying tube denting problem in the late 1970s	Should not be a problem today or in the future if good secondary chemistry is maintained (as defined in the Guidelines)
7	Low	High	High	Very unlikely based upon potential.	
8	Low	High	High		

Subgroup
11.20

Tube supports and/or preheater baffles
Carbon steel, drilled holes, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
71

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Several field observations of FAC of carbon steel tube supports etc. Big differences in field experience depending on secondary water chemistry.	Secondary water chemistry. Seawater ingress at condenser probably aggravates FAC. Some amines appear to offer good protection.
2	Medium	High	Medium	known issue	
3	Medium	Medium	Medium	I am not aware that this is a serious issue. Flow seemed to be adequate through the flow holes with no damage.	not significant
4	High	High	High	Known problem, with design modifications available	
5	High	High	High	several field failures; hydrazine concentration a factor; seen typically at top supports and U-bend supports	
6	Medium	Medium	Medium	Generic issue for carbon steels which has caused some plant problems	Predictive models are available which identify key variables
7	Medium	Medium	Medium	Depend upon the flow pattern and likely various location.	velocity and material
8	Medium	High	Medium		

Subgroup
11.20

Tube supports and/or preheater baffles
Carbon steel, drilled holes, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
71

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue for support plates. An active crack growth mechanism is necessary for fragmentation to occur and the precise value of fracture toughness is then academic.	
2	Low	High	Medium	Well characterized, but not in environment	
3	Low	Medium	Medium	Fractures propagated in the carbon steel tube supports with the large cumulative expansion due to denting. This was not a continuing problem..	not significant with out denting.
4	0	High	Medium	Not at all clear as to the possible embrittlement mechanism that is possible in this material /environment combination	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any proven FR mechanism that would lead to significant degradation for these materials under these operating conditions	Generic issue for carbon steels which has caused some plant problems
7	Low	High	Medium	EAC-related J-R curve reduction can be possible but very unlikely	
8	Low	High	High		

Subgroup
11.20

Tube supports and/or preheater baffles
Carbon steel, drilled holes, PWR secondary water
544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
71
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Since support plate corrosion sufficient to cause tube denting and support plate deformation has been avoided, SCC has become less likely. However, tube locking in the support plates can also cause support plate deformation so that cracking then becomes possible in the event of oxygen ingress.	Oxygen ingress at the condenser plus significant tube support plate deformation.
2	Low	High	Medium	known issue	
3	Medium	Medium	Medium	This was a serious issue so long as denting was important. When the denting diminished, the SCC of the tube supports diminished. Regardless, the tube supports of carbon steel did sustain SCC in deaerted water at high enough stress.	concentration of chemicals by superheat
4	Low	Medium	Medium	Highly dependant on the specific water chemistry that can form in the tube/support crevice	
5	Medium	High	High	seen in U-bend supports	
6	Low	Medium	Medium	Generally good experience to date but some potential for damage exists	Not expected to be a significant source of problems under nominal plant service conditions
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	High	Medium		

Subgroup
11.21

Tube supports
Stainless steel, Line contact/drilled holes
PWR secondary water, 544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
71

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible in principle in the event of significant hideout at tube contact lands but no known observations in service.	Significant acidic pollution and oxygen ingress.
2	Low	High	Medium		
3	0	High	High	Crevice corrosion is not an issue here.	Stainless steel in pure water will not sustain crevice corrosion.
4	Medium	Medium	Medium		
5	Low	High	High	good field experience; unlikely	
6	Low	Medium	Medium	Generally good experience to date but some potential for damage exists	Not expected to be a significant source of problems under nominal plant service conditions
7	Low	High	High	Very unlikely based upon potential.	
8	Low	High	Medium		

Subgroup
11.21

Tube supports
Stainless steel, Line contact/drilled holes
PWR secondary water, 544°F to 620°F, 1000 psia

Applies to BNL Part #s with prefix RCS-SG
71

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible in principle in the event of significant hideout at tube contact lands but no known observations in service.	Significant acidic pollution and oxygen ingress.
2	Low	High	Medium		
3	Low	Medium	Medium	No SCC has occurred due to lack of stresses from denting and due to line contact geometry.	No stresses
4	Low	Medium	Medium		
5	Low	High	High	good field experience; unlikely	
6	Low	Medium	Medium	Generally good experience to date but some potential for damage exists	Not expected to be a significant source of problems under nominal plant service conditions
7	Low	High	High	If surface of drill hole is heavily machined and cold worked, SCC may take place but may not propagate longer.	Cold work and residual stress.
8	Low	High	Medium		

Subgroup
11.22

SG tubes/roll transitions/sleeves/plugs
Alloy 600, SA and sensitized, PWR primary
556°F to 620°F, 2250 psia
For B&W OTSGs

Applies to BNL Part #s with prefix RCS-SG

Notes: for B&W OTSGs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known issue but possible in principle	
2	Medium	High	High	well characterized phenomenon	
3	Low	Medium	Medium	Never an issue	No issue
4	Medium	Medium	Medium	Possible vibration issues and high cycle fatigue but incidence very low.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
5	Low	High	High	possible but little field experience with this	
6	Low	Medium	Medium	Potential vulnerability but little field experience	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness
7	Medium	High	High	Potential problem depending upon stress sources	Source of cyclic stress.
8	Medium	High	Medium		

Subgroup
11.22

SG tubes/roll transitions/sleeves/plugs
Alloy 600, SA and sensitized, PWR primary
556°F to 620°F, 2250 psia
For B&W OTSGs

Applies to BNL Part #s with prefix RCS-SG

Notes: for B&W OTSGs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	A few cases of cracking in roll transitions from the primary side after long periods of service (18 years at Davis Besse)	SCC resistance of sensitized alloy 600 in primary water similar to that of alloy 600TT. However, the material is sensitized which leaves it vulnerable to mishaps with inadvertent ingress of chemicals such as thoisulfate from the reactor building spray tank - e.g. TMI-1
2	High	High	High	well characterized phenomenon	
3	Low	High	High	LPSCC from the inside primary environment has not produced significant SCC. The sensitized structure seems to resist SCC	No issue
4	Medium	Medium	Medium	Known issue even with alloy 600 TT when subject to high deformation and cold work	Alloy 600 MA and TT generically susceptible depending on stress level and extent of cold work.
5	High	High	High	possible and some instances reported in similar material (Bruce)	
6	Medium	Medium	Medium	Known issue for alloy 600 SA and sensitized when subject to high deformation and cold work	Generic susceptibility depending on stress level and extent of cold work. No fully qualified chemistry mitigation actions are available
7	Medium	High	High	A lot of field experiences in WH plants.	Water chemistry and condenser leak
8	Medium	High	High		

Subgroup
11.23

SG tubes secondary side including crevices
Alloy 600, SA and sensitized
PWR secondary water and superheated steam 544°F to 620°F, 1000 psia
For B&W OTSGs

Applies to BNL Part #s with prefix RCS-SG
32
Notes: for B&W OTSGs

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known pitting but possible in principle with hideout of acidic impurities	Acidic impurity ingress
2	Low	High	High		
3	Medium	Medium	Medium	Some pitting but seems associated with scratches	
4	Low	High	High	Known issue in sludge piles, associated with oxygen transients	
5	Medium	High	High	especially under shutdown conditions with aerated environment	
6	Low	High	Medium	Pitting probably is possible in sludge piles under oxidizing conditions during shutdowns	Ingress of oxygen should be avoided
7	Low	High	High	Well know issue in plants mostly in the past	Condenser leak
8	Low	High	High		

Subgroup
11.23

SG tubes secondary side including crevices
Alloy 600, SA and sensitized
PWR secondary water and superheated steam 544°F to 620°F, 1000 psia
For B&W OTSGs

Applies to BNL Part #s with prefix RCS-SG
32

Notes: for B&W OTSGs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Free-span cracking in superheated steam zone a known issue after over 20 years service. Also acid sulfur attack near lower tube sheet (due to resin ingress?).	SCC resistance of sensitized alloy 600 on secondary side similar to that of alloy 600TT
2	High	High	High	well characterized phenomenon	
3	High	High	High	Serious SCC in the superheated region, some in upper tube sheet.	
4	High	High	Medium	Known problem with 600MA to date, and expect problem to extend to alloy 600 TT. Lower knowledge value than 2 may be appropriate given difficulty in defining environmental system	
5	High	High	High	has occurred under deposits and in crevices	
6	High	High	Medium	Generic susceptibility for Alloy 600SA and sensitized	Cracking is likely but timing is unpredictable. No fully effective chemistry mitigation actions have been qualified to date
7	Medium	High	High	A lot of field experiences in WH plants.	Water chemistry and condenser leak
8	High	High	High		

Subgroup **11.23**

SG tubes secondary side including crevices
Alloy 600, SA and sensitized
PWR secondary water and superheated steam
544°F to 620°F, 1000 psia
For B&W OTSGs

Applies to BNL Part #s with prefix RCS-SG
32,54

Notes: for B&W OTSGs; for replacement SGs with alloy 690TT tubes

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	High cycle fatigue of tubes close to inspection lane	Combination of higher cross-flow velocities and surface corrosion on secondary side.
2	Medium	High	High	well characterized phenomenon	
3	Low	Medium	Medium	Does not seem serious except for possible ripple acceleration on SCC	No issue
4	Low	High	High		Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
5	Low	High	High	seen in similar material (Bruce)	
6	Low	Medium	Medium	A known vulnerability but field experience has been good	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
7	Low	Medium	Medium	Vibration stress is critical depending upon flow induced vibration.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	High	Medium		

Subgroup **11.23**

SG tubes secondary side including crevices
Alloy 600, SA and sensitized
PWR secondary water and superheated steam
544°F to 620°F, 1000 psia
For B&W OTSGs

Applies to BNL Part #s with prefix RCS-SG
32,54

Notes: for B&W OTSGs; for replacement SGs with alloy 690TT tubes

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Erosion by micron size particles of alumino silicates in upper bundle region at one plant	Secondary water chemistry capable of generating the solid particles of alumino-silicates
2	Medium	High	Medium		
3	Low	High	High	No anti-vibration bars There are some scratches that have caused SCC to initiate early	without scratches no issue since no anti-vib bars
4	Medium	High	Medium		
5	High	High	High	has occurred	
6	Medium	High	Medium	Known issue.	Depends on design and as-built anti-vibration bar clearances
7	Medium	High	High	Well know issue in plants mostly in the past	Flow velocity and design
8	Low	High	Medium		

Subgroup **12.1**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
1,4,8,11,12,13,14,15,17,22,24,25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration, particularly if fasteners are broken
5	Low	High	High	Very good field experience - no known problems	
6	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration, particularly if fasteners are broken or relaxed by neutron irradiation.
8	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration, particularly if fasteners are broken or relaxed by neutron irradiation.

Subgroup **12.1**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
1,4,8,11,12,13,14,15,17,22,24,25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Very good field experience - no known problems and no reason to suspect crack initiation in absence of excessive cold work.	Low dead weight stresses only
2	Low	High	Medium	Good field experience	
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	High	Very good field experience - no known problems	Low dead weight stresses only
5	Low	High	High	Very good field experience - no known problems	
6	Low	High	High	Very good field experience - no known problems	SCC vulnerability may increase with fluence but ECPs are low
7	Low	High	High	Very good field experience - no known problems	Low dead weight stresses only
8	Low	High	High	Very good field experience - no known problems	Low dead weight stresses only

Subgroup **12.2**

Austenitic weld HAZs
Types 304, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
1,2,3,4,11,12,13,14,19

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Cyclic loads. Not known if CUFs can be significant
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Very good field experience - no known fatigue problems. However confidence and knowledge scoring downgraded from 3/3 in 12.1 until recent corrosion fatigue corrosion fatigue data is understood.	Applies to only CE welded internals
5	Low	High	High	Very good field experience - no known fatigue problems	
6	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only an issue for CE plant welded internals.
7	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only a potential issue for CE plant welded internals.
8	Low	High	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only a potential issue for CE plant welded internals.

Subgroup **12.2**

Austenitic weld HAZs
Types 304, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
1,2,3,4,11,12,13,14,19

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience over more than 30 years - no known cracking due to SCC .	Negligible dissolved oxygen in PWR primary water
2	Low	High	High	Very good field experience - no known cracking due to SCC - negligible dissolved oxygen	
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	High	Very good field experience - no known cracking due to SCC - negligible dissolved oxygen	Only a potential issue for CE plant welded internals where neutron doses are high.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	Very good field experience - no known cracking due to SCC - negligible dissolved oxygen	Only a potential issue for CE plant welded internals where neutron doses are high. Irradiation creep a mitigating factor.
8	Medium	High	High	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	Only a potential issue for CE plant welded internals where neutron doses are high. Irradiation creep a mitigating factor.

Subgroup **12.3**

Austenitic to austenitic weld metals
Type 308, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not separately listed
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Cyclic loads. Not known if CUFs can be significant
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Medium	Medium	Medium	Very good field experience - CE plants primarily	
5	Medium	Medium	Medium	Very good field experience - CE plants primarily	
6	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only an issue for CE plant welded internals
7	Medium	Medium	Medium	Very good field experience - CE plants primarily	Effects of LT aging is not clear.
8	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only an issue for CE plant welded internals

Subgroup **12.3**

Austenitic to austenitic weld metals
Type 308, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not separately listed
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
8	Low	Medium	Medium	Aging and in-situ testing	

Subgroup **12.3**

Austenitic to austenitic weld metals
Type 308, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not separately listed
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored.	
3	Medium	Medium	Medium	This could become a long term problem related to cold work similarities. Should be carefully studied	
4	Low	High	High	Unlikely for stainless steels, due to low corrosion potential, and duplex microstructure	
5	Low	Medium	Medium	possible concern depending on stress levels	
6	Low	Medium	High	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Low	High	High	After long term aging, microstructure may have a susceptibility to SCC associated with hardening and microstructural changes	Aging microstructure and hardening
8	Low	High	High		

Subgroup **12.4**

Cold worked austenitic stainless steel
Type 316, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
3,9,16,18

Notes:

Thermal Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Some troubling lab data available showing long term relaxation of cold worked stainless steel split pins at typical reactor hot leg temperature.	Initial stress, temperature and time
2	Low	Medium	Medium	Some lab data available	Initial stress, temperature and time
3	Low	Medium	Medium	With low fluence, creep is not a major contribution	
4	Low	High	Medium	Little concern at relatively low homologous temperatures, but uncertain about effect of cold work; hence knowledge decrease to 2	
5	High	High	High	At low fluence, thermal creep is probably not a major concern	
6	Low	Medium	Medium	Stress relaxation can occur at low dpa leading to concern about the functionality of springs	Initial stress, temperature and time
7	Low	Medium	Medium	Some troubling lab data available	Initial stress, temperature and time
8	Low	Medium	Medium	Some troubling lab data available	Initial stress, temperature and time

Subgroup **12.4**

Cold worked austenitic stainless steel
Type 316, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
3,9,16,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good experience with very few problems in absence of significant irradiation dose. A few cases of bolts wearing loose	Flow induced vibration.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	
3	Low	Medium	Medium	The corrosion fatigue is more likely a contributor to SCC as a ripple addition.	
4	Medium	Medium	Low	Good experience with very few problems - beware effect of irradiation relaxation of baffle bolts at high neutron doses	Flow induced vibration if bolt loads are relaxed by irradiation creep.
5	Medium	Medium	Low	Good experience with very few problems - beware effect of relaxation	
6	Medium	Medium	Low	Good experience with very few problems - beware effect of irradiation relaxation of baffle bolts at high neutron doses	Flow induced vibration if bolt loads are relaxed by irradiation creep.
7	Medium	Medium	Low	Good experience with very few problems - beware effect of relaxation	
8	Medium	Medium	Low	Good experience with very few problems - beware effect of irradiation relaxation of baffle bolts at high neutron doses	Flow induced vibration if bolt loads are relaxed by irradiation creep.

Subgroup **12.4**

Cold worked austenitic stainless steel
Type 316, PWR primary water, ≤0.5 dpa (low fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
3,9,16,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Cold work limited to 20%. No evidence of SCC initiation and growth in more than 30 years of service	
2	--	--	--	could be an issue depending on welding techniques used	
3	Medium	Medium	Medium	The cold worked SS is more prone to SCC	Pits and defects will accelerate initiation
4	Low	High	Medium	Low potential, hence low susceptibility in primary environment, knowledge score decreased to 2 to account for role that uncertainty that cold work may increase the susceptibility	
5	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	
6	Medium	High	High	Cold-worked material is inherently more susceptible than annealed material but field experience has been good.	SCC vulnerability may increase with fluence but ECPs are low
7	Medium	Medium	Medium	Cold work and LTA may increase SCC susceptibility.	Lab. Data showed significant amount of SCC acceleration.
8	Medium	Medium	Medium	Good field experience - no known cracking due to SCC, but major concerns in lab data.	

Subgroup **12.5**

Cast austenitic SS components
PWR primary water
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
2,19,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far.
2	Medium	Medium	Medium	Possible environmental effects	
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Low	Doubt lab data base is as good as for wrought materials; therefore decrease knowledge score. Reasonable field experience so far.	
5	--	Low	Low		
6	Low	Medium	Medium	Very good field experience. Doubts on magnitude of environmental effects in service	Flow induced vibration is main driver.
7	Low	High	High	Less environmental effects in CAST	
8	Low	Medium	Low		

Subgroup **12.5**

Cast austenitic SS components
PWR primary water
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
2,19,20

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized loss of toughness due to thermal aging - very skeptical that low dose irradiation contributes synergistically as suggested by some NRC specialists.	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Medium	High	Low	Known issue - question whether irradiation contributes significantly and at what fluence; hence decrease in knowledge score	
5	Medium	High	High	Known issue - very doubtful that irradiation contributes significantly	
6	Low	High	High	Thermal embrittlement of cast austenitics is a well characterized phenomenon	Known issue. Effective prediction models.
7	Low	High	High	Well characterized - very skeptical that irradiation contributes synergistically as suggested in USA.	Known issue. Effective prediction models.
8	Medium	High	Medium	Characterized, but not in environment	Known issue. Effective prediction models.

Subgroup **12.5**

Cast austenitic SS components
PWR primary water
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
2,19,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating testing program in Europe to assess long term risk
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
7	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with aging	Sufficient doubts to initiate testing program in Europe to assess long term risk

Subgroup **12.6**

Austenitic solution annealed holdown spring
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
7

Notes:

Thermal Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue that has prompted replacement with martensitic S/S in many plants	Initial stress, temperature and time.
2	Medium	High	Medium	Known issue	
3	Medium	Medium	Medium	Some creep could be expected but not aware of measurements	Consider replacement if critical spring force
4	Medium	High	Medium	Known issue that has prompted replacement with martensitic S/S in many plants	Initial stress, temperature and time.
5	Medium	High	Medium	Known issue that has prompted replacement with martensitic S/S	
6	Medium	High	Medium	Known issue that has prompted replacement with martensitic S/S in many plants	Initial stress, temperature and time.
7	Medium	High	Medium	Known issue that has prompted replacement with martensitic S/S in many plants	Initial stress, temperature and time.
8	Medium	High	Medium	Known issue that has prompted replacement with martensitic S/S in many plants	Initial stress, temperature and time.

Subgroup **12.6**

Austenitic solution annealed holdown spring
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
7

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects in the field.	Only likely to be a problem where present nominal CUF>0.1approx, which is unlikely here
2	--	--	--	components which can be replaced I do not consider to be problems in this context, should be captured by inspection and maintenance programs	
3	Low	Medium	Medium	Not aware of fatigue issue. Fatigue may be minimized with cold work.	
4	Low	High	Medium		
5	--	Low	Low		
6	Low	Medium	Medium	Very good field experience. Doubts on magnitude of environmental effects in service	Flow induced vibration is main driver.
7	Medium	Medium	Medium	Long term performance is not clear	Relaxation under stress and stress changes
8	Low	High	Medium		

Subgroup **12.6**

Austenitic solution annealed holdown spring
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
7

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	--	--	--	components which can be replaced I do not consider to be problems in this context, should be captured by inspection and maintenance programs	
3	Medium	Medium	Medium	Cold worked SS may sustain SCC since cold work is well established to increase the proneness to SCC.	Scratches and surface abuse
4	Low	High	High	Cracking susc must be low for solution annealed+low potential+low fluence	
5	--	Low	Low		
6	Low	High	High	Very good field experience - no known problems	SCC vulnerability may increase with fluence but ECPs are low
7	Low	High	High	Very good field experience - no known problems	Low dead weight stresses only
8	Low	High	Medium		

Subgroup **12.7**

High strength fasteners/springs
Alloys X750, 718, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
5,6,10,21,23

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue since components break only when a slow crack growth mechanism is active and then the precise crack size for the final failure is of only academic interest.	
2	--	--	--	components which can be replaced I do not consider to be problems in this context, should be captured by inspection and maintenance programs	
3	Medium	Medium	Medium	If surface abuse or defects fracture is possible	Check surface finish
4	Medium	High	Medium	X750 known to be sensitive LTCP, but uncertain as to whether the required temperature/strain rate conditions can be met during reactor shutdown	
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals. Alloy X750 is particularly susceptible	It's not clear if the conditions required for LTCP are met in PWR service. The likelihood appears greatest during cooldown (<150C)
7	Medium	Low	Low	Potential reduction of FR due to hydrogen. No evidence of reduction of fracture toughness.	EAC and mechanical crack growth are different.
8	Medium	Medium	Medium		

Subgroup **12.7**

High strength fasteners/springs
Alloys X750, 718, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
5,6,10,21,23

Notes:

Irradiation Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue only at high neutron doses such as fuel element grid springs	Neutron dose dependent
2	Medium	High	Medium	Known issue at high doses	
3	Low	Medium	Medium	Probably not an issue but should be checked over long times.	Inspect
4	Medium	High	Medium	Known issue only at high doses	Neutron dose dependent
5	High	High	High	Known issue only at high doses	
6	Low	High	Medium	Known issue only at high doses	Neutron dose dependent
7	Medium	High	Medium	Known issue only at high doses	Neutron dose dependent
8	Medium	High	Medium	Known issue only at high doses	Neutron dose dependent

Subgroup **12.7**

High strength fasteners/springs
Alloys X750, 718, PWR primary water
556°F to 620°F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
5,6,10,21,23

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue for alloy X750 - alloy 718 usually very reliable	Stress, surface finish, design detail and heat treatment all crucial
2	--	--	--	components which can be replaced I do not consider to be problems in this context, should be captured by inspection and maintenance programs	
3	Medium	Medium	Medium	High strength materials always prone to SCC unless some ameliorative actions taken such as shot peen or some surface heat treat.	Inspect
4	Medium	High	Medium	Known issue for alloy X750 - alloy 718 usually very reliable	Stress, surface finish, design detail and heat treatment all crucial
5	Medium	High	Medium	Known issue for alloy X750 - alloy 718 usually very reliable	
6	Medium	High	Medium	Known issue for alloy X750 - alloy 718 usually very reliable	Stress, surface finish, design detail and heat treatment all crucial
7	Medium	High	Medium	Known issue for alloy X750 - alloy 718 usually very reliable	Stress, surface finish, design detail and heat treatment all crucial
8	Medium	High	Medium	Known issue for alloy X750 - alloy 718 usually very reliable	Stress, surface finish, design detail and heat treatment all crucial

Subgroup **12.8**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,24,25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration, particularly if fasteners are broken or relaxed by neutron irradiation.
2	Medium	High	High	Potential problem with uprating	
3	Medium	Medium	Medium	Corrosion fatigue probably contribute to SCC as ripple loading	
4	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration, particularly if fasteners are broken
5	--	Low	Low		
6	Low	High	High	Very good field experience. Good lab data base although doubts on magnitude of environmental effects in service	Flow induced vibration, particularly if fasteners are broken or relaxed by neutron irradiation.
7	Medium	Medium	Medium	Need more data including environmental effects.	
8	Medium	High	High		

Subgroup **12.8**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,24,25

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
2	Medium	High	High	Known issue	
3	Medium	Medium	Medium	Long time effects not clear but lowering in fracture toughness occurs.	Time
4	Medium	High	Medium	Irradiation embrittlement a recognized phenomenon for SS. Scatter in K1c values needs to be evaluated for safety margin evaluations	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
5	--	Low	Low		
6	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
7	Medium	Low	Low	Potential reduction of FR due to hydrogen. No evidence of reduction of fracture toughness.	EAC and mechanical crack growth are different.
8	Medium	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs

Subgroup **12.8**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,24,25

Notes:

Irradiation Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Medium	High	Medium	Known issue only at high doses.	Neutron dose dependent.
4	Medium	High	Medium	Irradiation induced creep certainly a relevant factor. Could be argued that data base is not sufficient to manage situation; hence lower knowledge score.	
5	Low	Medium	Medium	seems unlikely except for highly stressed comonents	
6	Medium	Medium	Medium	Only an issue at high doses	Local neutron flux
7	Low	High	High	Depend upon the geometry and design	dpa
8	Medium	High	High	Irradiation creep will occur, but may not be significant if loads are small	

Subgroup **12.8**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,24,25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known problems	Low dead weight stresses only
2	Medium	High	Medium	insufficient experience and data at high doses, low potential does not eliminate possibility	
3	Medium	Medium	Medium	SCC at long times owing to changes in composition of grain boundaries, radiation hardening, slow rate of SS SCC.	Time
4	Low	High	High	Very good field experience - no known problems	Low dead weight stresses only
5	--	Low	Low		
6	Low	High	High	Very good field experience - no known problems	SCC vulnerability may increase with fluence but ECPs are low
7	High	Medium	Medium	Hardening is critical and well known in laboratory.	RIS is also important but not clear which element are detrimental. Si is likely.
8	Medium	High	High		

Subgroup **12.8**

Austenitic stainless steel plates/tubes
Type 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
15,24,25

Notes:

Swelling

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components affected
2	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components affected
3	Medium	Medium	Medium	Swelling has been demonstrated to occur. Major concern if the swelling is non-uniform and bending results with uncertain effects	Time
4	Medium	Medium	Medium	Only localized very highly irradiated components affected	Only localized very highly irradiated components affected
5	Medium	Medium	Medium	Only localized very highly irradiated (and gamma-heated) components affected	
6	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only very highly irradiated near-core components affected
7	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components affected
8	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components affected

Subgroup **12.9**

Austenitic weld HAZs
Types 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,25

Notes: 15 CE plants only

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Cyclic loads. Not known if CUFs can be significant
2	Low	Medium	Medium	Limited lab data	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	
4	Low	Medium	Low	no known fatigue problems. However confidence and knowledge scoring downgraded from 3/3 in 12.1 until corrosion fatigue data obtained in irradiation field	Applies to only CE welded internals
5	--	Low	Low		
6	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only a potential issue for CE plant welded internals.
7	Medium	Medium	Medium	Need more data including environmental effects.	
8	Medium	High	High		

Subgroup **12.9**

Austenitic weld HAZs
Types 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,25

Notes: 15 CE plants only

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%)
2	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
4	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
5	--	Low	Low		
6	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
7	Medium	Low	Low	Potential reduction of FR due to hydrogen. No evidence of reduction of fracture toughness.	EAC and mechanical crack growth are different.
8	Medium	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs

Subgroup **12.9**

Austenitic weld HAZs
Types 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
11,12,13,14,15,25

Notes: 15 CE plants only

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Very good field experience - no known cracking due to SCC	Irradiation creep a mitigating factor.
2	Medium	Medium	Medium	Good experience - limited lab data	
3	Low	Medium	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Effects of radiation not clear but will increase proneness to SCC	Special surface conditions on welds.
4	Medium	High	Low	no known cracking due to SCC - negligible dissolved oxygen. Knowledge value decreased to 1 due to relative lack of data under irradiation conditions. Suscep. Value increased to 2 to account for expected irradiation effect (by analogy to BWR experience)	
5	Medium	Medium	Medium		
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC in weld HAZs.	Not anticipated to be a problem under nominal operating conditions. Potential issue only for CE plants with welded internals
7	High	Medium	Medium	Hardening is critical and well known in laboratory.	RIS is also important but not clear which element are detrimental. Si is likely.
8	Medium	High	Medium	Good field experience - no known cracking due to SCC, but major concerns in lab data. No difference between 304 and 316SS.	

Subgroup **12.9**

Austenitic weld HAZs
Types 304, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
15,25

Notes: 15 CE plants only

Swelling

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components affected
2	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected
3	Medium	Medium	Medium	Swelling is something like the buildup of oxide	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including gamma heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected
5	Medium	Medium	Medium	Only localized very highly irradiated components affected	
6	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected
7	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected
8	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected

Subgroup **12.10**

Austenitic to austenitic weld metal components
Type 308, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not listed separately
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Cyclic loads. Not known if CUFs can be significant
2	Low	Medium	Medium	Limited lab data	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Medium	Medium	Low	Very good field experience - CE plants primarily Knowledge decreased to 1 due to lack of irradiation data	
5	--	Low	Low		
6	Medium	Medium	Medium	Very good field experience - no known fatigue problems although doubts on magnitude of environmental effects in service	Only an issue for CE plant welded internals
7	Medium	Medium	Medium	Need more data including environmental effects.	
8	Medium	Medium	Medium		

Subgroup **12.10**

Austenitic to austenitic weld metal components
Type 308, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not listed separately
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
2	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
3	Low	Medium	Low	The Mills effect seems to apply less at high temperature than at lower temperatures. However, this effect has not really been adequately explored with respect to alloys and temperature.	Not clear what to say since the domains of the phenomenon are not clear
4	Low	High	Medium	Predictable but tolerable hardening and loss of toughness due to neutron irradiation. Uncertainty in K1c values gives lower knowledge score.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
5	--	Low	Low		
6	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
7	Medium	Low	Low	Potential reduction of FR due to hydrogen. No evidence of reduction of fracture toughness.	EAC and mechanical crack growth are different.
8	Medium	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs

Subgroup **12.10**

Austenitic to austenitic weld metal components
Type 308, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not listed separately
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Irradiation creep a mitigating factor.
2	Medium	Medium	Medium	Good experience - limited lab data	
3	Medium	Medium	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Radiation hardening will intensify the SCC in addition to other effects of radiation	Special surface conditions on welds.
4	Medium	Medium	Low		
5	Medium	Medium	Medium		
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	High	Medium	Medium	Hardening is critical and well known in laboratory. Synergy effects of irradiation and LTA is not clear.	RIS is also important but not clear which element are detrimental. Si is likely.
8	Medium	Medium	Medium		

Subgroup **12.10**

Austenitic to austenitic weld metal components
Type 308, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
Not listed separately
Notes:

Swelling

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected
2	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected
3	Medium	Medium	Medium	At long times swelling can be expected to damage components both for bending and elongation. May also accelerate SCC due to differential stresses.	
4	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected
5	Medium	Medium	Medium	Only localized very highly irradiated (and gamma-heated) components affected	
6	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected
7	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected
8	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected

Subgroup **12.11**

Cold worked austenitic stainless steel components
Type 316, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
16

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Low	Good experience with very few problems - beware effect of irradiation relaxation of baffle bolts at high neutron doses	Flow induced vibration if bolt loads are relaxed sufficiently by irradiation creep.
2	Low	Medium	Medium	Limited lab data	
3	Low	Medium	Medium	The corrosion fatigue is more likely a contributor to SCC as a ripple addition.	
4	Medium	Medium	Low		
5	--	Low	Low		
6	Medium	Medium	Low	Good experience with very few problems	Flow induced vibration if bolt loads are relaxed by irradiation creep.
7	Medium	Medium	Medium	Need more data including environmental effects.	
8	Medium	Medium	Medium		

Subgroup **12.11**

Cold worked austenitic stainless steel components
Type 316, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
16

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
2	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
3	Low	Medium	Medium	The aging of cast stainless steels produces uncertainties but the fracture resistance is lowered. It is not clear how this issue is a problem for longer times. No sense of statistical distribution of fracture resistance with metallurgical variables. More intense with higher fluence.	Most likely incided when defects are present. Possible pitting due to metallurgical defects.
4	Low	High	Medium	Uncertainty in K1c values gives lower knowledge score.	
5	--	Low	Low		
6	Low	High	High	Predictable but tolerable hardening and loss of toughness due to neutron irradiation.	Only an issue for CE plant welded internals. Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
7	Medium	Low	Low	Potential reduction of FR due to hydrogen. No evidence of reduction of fracture toughness.	EAC and mechanical crack growth are different.
8	Medium	Medium	Medium		

Subgroup **12.11**

Cold worked austenitic stainless steel components
Type 316, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
16

Notes:

Irradiation Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Known issue only at high doses	Neutron dose dependent
2	High	High	Medium	Known issue only at high doses	Neutron dose dependent
3	Medium	Low	Low	Some creep but the rate and character are not well defined.	
4	High	High	Medium	Known issue only at high doses	Neutron dose dependent
5	--	Low	Low		
6	High	High	Medium	Known issue only at high doses	Neutron dose dependent
7	High	High	Medium	Known issue only at high doses	Neutron dose dependent
8	High	High	Medium	Known issue only at high doses	Neutron dose dependent

Subgroup **12.11**

Cold worked austenitic stainless steel components
Type 316, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
16

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)
2	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)
3	High	High	High	Cold worked stainless steel can sustain SCC rapidly if stresses are not relieved and if there is surface abuse. There is good agreement on the data among several investigators althoughand there appears to be some but not extensive field data to support this.	Surface abuse pits and defects will accelerate initiation
4	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)
5	--	Low	Low		
6	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)
7	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)
8	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)

Subgroup **12.11**

Cold worked austenitic stainless steel components
Type 316, PWR primary water, >0.5 dpa (high fluence)
556°F to 620 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-RVI
16

Notes:

Swelling

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components affected. Cold work delays onset relative to solution annealed stainless steel.
2	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	
3	Medium	Medium	Medium	Swelling increase with fluence. Non uniform swelling produce bending and non uniform effects. Produces stresses that may affect SCC.	
4	Medium	Medium	Medium		
5	--	Low	Low		
6	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only an issue for CE plant welded internals - only localized very highly irradiated components affected
7	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected
8	High	Medium	Medium		

Subgroup **12.12**

High strength baffle bolts
Type A286, alloy X750, >0.5 dpa (high fluence)
PWR primary water, 556°F to 620 °F, 2250 psia
For B&W RVIs

Applies to BNL Part #s with prefix RCS-RVI
16

Notes: for B&W RVIs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known problems but possible aggravating effect of irradiation creep relaxation at high neutron doses	Flow induced vibration if bolt loads are relaxed sufficiently by irradiation creep but probably less susceptible than stainless steel analogues
2	Low	Medium	Medium	Know of no issue, may be a problem at high doses.	
3	Low	Medium	Medium	Corrosion fatigue most likely adds to SCC as ripple effect	
4	Medium	Medium	Low	Effect of irradiation unknown	
5	--	Low	Low		
6	Medium	Medium	Medium	Only an issue if bolts loosen in service	
7	Medium	Medium	Medium	Need more data including environmental effects.	
8	Medium	High	Medium		

Subgroup **12.12**

High strength baffle bolts
Type A286, alloy X750, >0.5 dpa (high fluence)
PWR primary water, 556°F to 620 °F, 2250 psia
For B&W RVIs

Applies to BNL Part #s with prefix RCS-RVI
16

Notes: for B&W RVIs

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Probable loss of toughness due to neutron irradiation but not obvious that any undesirable practical consequence would ensue.	Neutron dose dependent. Unacceptable loss of toughness if significant swelling (>~6%) occurs
2	Medium	Medium	Medium	Possible issue at high neutron doses	
3	Medium	Medium	Medium	FR decreases with radiation damage and is already low owing to the high strength	
4	Medium	High	Low	X750 known to be sensitive LTCP, but uncertain as to whether the required temperature/strain rate conditions can be met during reactor shutdown. Synergism with irradiation hardening unknown	
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals. Alloy X750 is particularly susceptible	It's not clear if the conditions required for LTCP are met in PWR service. The likelihood appears greatest during cooldown (<150C). It's also not clear how this phenomenon interacts with loss of fracture resistance due to radiation effects
7	Medium	Low	Low	Potential reduction of FR due to hydrogen. No evidence of reduction of fracture toughness.	EAC and mechanical crack growth are different.
8	Medium	High	Medium		

Subgroup
12.12

High strength baffle bolts
Type A286, alloy X750, >0.5 dpa (high fluence)
PWR primary water, 556°F to 620 °F, 2250 psia
For B&W RVIs

Applies to BNL Part #s with prefix RCS-RVI
16

Notes: for B&W RVIs

Irradiation Creep

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue only at high doses but less affected than highly irradiated austenitic stainless steel.	Neutron dose dependent
2	High	High	Medium	Known issue only at high doses	Neutron dose dependent
3	Medium	Medium	Medium	With time, irradiation creep increases.	
4	High	High	Medium	Known issue only at high doses	
5	--	Low	Low		
6	Medium	High	Medium	Known issue only at high doses	Neutron dose dependent
7	High	High	Medium	Known issue only at high doses	Neutron dose dependent
8	High	High	Medium		

Subgroup **12.12**

High strength baffle bolts
Type A286, alloy X750, >0.5 dpa (high fluence)
PWR primary water, 556°F to 620 °F, 2250 psia
For B&W RVIs

Applies to BNL Part #s with prefix RCS-RVI
16

Notes: for B&W RVIs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Known issue for alloy X750 without irradiation. One report of possible effect of helium embrittlement of alloy X750 due to nuclear transformation of boron segregated to grain boundaries. A286 is notoriously unreliable in PWR primary water and stresses must be kept below the elastic limit even at stress concentrations.	Stress, surface finish, design detail and heat treatment all crucial
2	High	High	Medium	Known issue at high doses but all influencing factors not yet identified	Neutron dose and temperature dependent (including g heating effects)
3	Medium	High	Medium	High strength baffle bolts become more prone to SCC with increased radiation damage depending on various ameliorative treatments.	Defects and surface abrasions
4	Medium	High	Medium	Known issue for alloy X750	Stress, surface finish, design detail and heat treatment all crucial
5	--	Low	Low		
6	High	High	Medium	Known issue for alloy X750 - alloy 718 usually OK	Stress, surface finish, design detail and heat treatment all important
7	High	Medium	Medium	Hardening is critical and well known in laboratory. Synergy effects of irradiation and LTA is not clear.	RIS is also important but not clear which element are detrimental.
8	High	High	Medium		

Subgroup **12.12**

High strength baffle bolts
Type A286, alloy X750, >0.5 dpa (high fluence)
PWR primary water, 556°F to 620 °F, 2250 psia
For B&W RVIs

Applies to BNL Part #s with prefix RCS-RVI
16

Notes: for B&W RVIs

Swelling

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating) same as austenitic stainless steels	Only localized very highly irradiated components affected.
2	Medium	Medium	Medium	High neutron doses reaquired but uncertainty on dose threshold and effect of temperature (including g heating)	
3	Medium	Medium	Medium	Swelling increases with time and will produce affects according to gradient in radiation that leads to bending and special stresses.	
4	Medium	Medium	Medium		
5	--	Low	Low		
6	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only localized very highly irradiated components are affected
7	Medium	Medium	Medium	High neutron doses required but uncertainty on dose threshold and effect of temperature (including g heating)	Only a potential issue for CE plant welded internals - only localized very highly irradiated components affected
8	High	Medium	Medium		

Subgroup **13.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-LPBYP
1-38

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Cl in insulation or from ocean aerosols.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **13.1**

All stainless steel components
External surfaces when at <150°C
Containment air
Normally dry when at low temp

Applies to BNL Part #s with prefix RCS-LPBYP
1-38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **13.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
7

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Cyclic loads.
2	Low	High	High	Reasonable lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	Medium	Medium	Good lab data base but doubts on magnitude of environmental effects. .	Very good field experience. Only likely to be a problem where present nominal CUF>0.1approx.
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Extensive lab data base. Field experience has been good to date	Only likely to be a problem if design CUF is greater than about 0.1. Surface finish effects may be important.
7	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	High	High	Good lab data base but doubts on magnitude of environmental effects in service	Only likely to be a problem where present nominal CUF>0.1approx.

Subgroup **13.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
7

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Low	Very good field experience - no known cracking due to SCC. However indications from lab data that surface cold work may be issue. Hence decrease in knowledge value	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	Low	High	High	needs high stress or cold work	
6	Low	Medium	Medium	SCC requires severe surface damage and/or high residual stresses which makes cracking in stainless piping unlikely except in, and adjacent to, welds	Not expected to be a problem in PWR piping unless there are components present that were heavily cold-worked and not solution annealed
7	Medium	High	High	Cold worked 300 SS can show IGSCC in PWR	Cold work
8	Low	High	High		

Subgroup **13.3.1**

Austenitic weld HAZs
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
3,7,10,15,17,19,22,24,27,30,33,37,38

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF is greater than about 0.1. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27

Subgroup **13.3.1**

Austenitic weld HAZs
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
3,7,10,15,17,19,22,24,27,30,33,37,38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a significant problem under nominal operating conditions.
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **13.3.2**

Austenitic weld HAZs
Type 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
3,7,10,15,17,19,22,24,27,30,33,37,38

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only likely to be a problem where CUF is greater than about 0.1. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27

Subgroup
13.3.2

Austenitic weld HAZs
Type 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
3,7,10,15,17,19,22,24,27,30,33,37,38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	Low	High	High	Very good field experience - no known cracking due to SCC	
6	Low	Medium	Medium	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a significant problem under nominal operating conditions.
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **13.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
1,2,4,5,6,8,9,11,12,13,14,16,18,20,21,23,25,26,28,29,31,32,34,35,36

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, 28
2	Medium	Medium	Medium	Lab data limited. Good field experience.	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, 28
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, 28
5	Medium	Medium	Medium	Difficult to apply laboratory data to plant experience; plant experience good to date	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue. (I don't recall much data on duplex materials however.)	Only likely to be a problem where CUF is greater than about 0.1. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, and 28
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, 28
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, 28

Subgroup **13.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
1,2,4,5,6,8,9,11,12,13,14,16,18,20,21,23,25,26,28,29,31,32,34,35,36

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Aging and in-situ testing concerns	

Subgroup **13.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
1,2,4,5,6,8,9,11,12,13,14,16,18,20,21,23,25,26,28,29,31,32,34,35,36

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	High	Very good field experience - no known cracking due to SCC - negligible dissolved oxygen	
5	Low	High	High	if weld sensitized	
6	Low	Medium	Medium	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	HAZ is a bigger concern, but aging of weld metals may create a problem. Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **13.5**

Cast austenitic SS components
PWR primary water
600 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
38

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible environmental effects on fatigue life but no known data.	Good field experience so far.
2	Medium	Medium	Medium	Possible PWR primary water environmental effects.	Only likely to be a problem where present nominal CUF>0.1 approx.
3	Low	Medium	Medium	Corrosion fatigue may exert its effect more through being a ripple on SCC rather than an effect by itself. This depends on the cyclic frequency. Initiation of corrosion fatigue depends on surface conditions and work on such dependencies have not been conducted.	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Medium		
5	--	Low	Low		
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
7	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	High	Medium		

Subgroup **13.5**

Cast austenitic SS components
PWR primary water
600 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
38

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	In general, performance has been good. The aging of cast stainless steels produces uncertainties, and the fracture resistance is lowered. It is not clear how this change develops over longer time. There are no data for statistical distribution of fracture resistance with metallurgical variables. There is no clear data on effects of fabrication, surface roughness, machining, residual stresses, and abusive grinding. Also, the possible similarity to the pattern observed by Mills has not been investigated. Since a significant change in the dependence of FR on time at temperature has already been observed, the possibilities of more implications are clear.	Most likely incided when defects are present. Possible pitting due to metallurgical defects. Accelerated at lower temperatures although the boundaries for such dependencies are not clear.
4	Low	High	Medium	Well characterized, but some concern about extremes in composition (see CASS topical) which lowers knowledge score	Known issue. Effective prediction models.
5	Medium	High	High	Known issue	
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Low	High	High	Well characterized	Known issue. Effective prediction models.
8	Medium	High	High	Well characterized, but no in-situ	Known issue. Effective prediction models.

Subgroup **13.5**

Cast austenitic SS components
PWR primary water
600 °F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Low	Low	A theoretical concern at present	Sufficient doubts to consider initiating test program in Europe to assess long term risk.
2	Low	Low	Low	A theoretical concern at present	Manufacturing practice can lead to very inhomogeneous structure, with large local variations in ferrite content and fine enclosed cracks. This could lead to problems of integrity, FR and SCC. May be an area for further investigation.
3	Low	Medium	Medium	While performance in service is good generally, there are not adequate data for effects of metallurgical variables, residual stresses, abusive machining no ranges of potential. Since the toughness is observed to change with time, then it is reasonable that the intensity of SCC should change with time. The mechanisic framework for SCC of the cast SS is not known even to a lesser extent than some more extensively evaluated materials.	Abusive surface treatments should be important as well as dings and dents during operation. Perhaps, hydrogen absorption may also be important.
4	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
5	Low	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk.
7	Low	Low	Low	A theoretical concern at present	Sufficient doubts to initiate testing program in Europe to assess long term risk
8	Medium	Low	Low	Magnitude of problem unclear but of concern, esp. with aging	Sufficient doubts to initiate testing program in Europe to assess long term risk

Subgroup **13.6**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
3,10,15,17,19,22,24,27,30,33,37

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies	Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
2	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Low	Surface finish a known problem + possible environmental effects. Uncertain evaluation of thermal eddies and impact on strain amplitude values	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Medium	Medium	Medium	Surface finish a known problem + possible environmental effects	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem if CUF is greater than about 0.1. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
7	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
8	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27

Subgroup **13.6**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix RCS-LPBYP
3,10,15,17,19,22,24,27,30,33,37

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	Medium	Unlikely to be a problem of SCC at these low potentials, based on a lot of laboratory and field experience data. Uncertain source of sustained stress; cracking may occur at surface damage but unlikely to propagate far	
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC	Not anticipated to be a problem under nominal operating conditions

Subgroup **14.1**

All stainless steel components
External surfaces
Auxiliary building air
Ambient Temp, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
1-56
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Medium	High	High	Pits may initiate cracking/deposits on surface are initiation sites	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **14.1**

All stainless steel components
External surfaces
Auxiliary building air
Ambient Temp, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
1-56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **14.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
4,6,16,20,32,54,56
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **14.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
4,6,16,20,32,54,56

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Availability of sulfate and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **14.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
4,6,16,20,32,54,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	needs high stress and corrosive environment; unlikely here	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Low	High	High		

Subgroup **14.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
4,6,16,20,22,26,28,32,34,50,54,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues.	
3	Low	High	Medium	Temperature too low. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup
14.3

Austenitic weld HAZs
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
4,6,16,20,22,26,28,32,34,50,54,56
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	MIC organisms available
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **14.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
4,6,16,20,22,26,28,32,34,50,54,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	Low	High	Medium	Not likely at these low temperatures	
3	Low	High	High	Temperature too low. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Some field cracking due to SCC - presumably chloride contamination, or to critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup
14.4

Austenitic to austenitic weld metals
Type 308
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR

1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,23,24,25,27,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,51,52,53,54,55,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues.	
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **14.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR

1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,23,24,25,27,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,51,52,53,54,55,56

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	MIC organisms available
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **14.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR

1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,23,24,25,27,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,51,52,53,54,55,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Potential problem caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Low	High	High	Very limited concern at 100F	

Subgroup **14.5**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
22,26,28,34,50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs or thermal cycling during use
2	0	High	Medium	No known loading issues.	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **14.5**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
22,26,28,34,50

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	MIC organisms available
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **14.5**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
22,26,28,34,50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	needs high stresses or cold work	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
8	Low	High	High		

Subgroup **14.6**

Socket welds
Type 304
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
9,11,12,18,39,40,42,55

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium	high cyclic stresses a concern	
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **14.6**

Socket welds
Type 304
Borated demin water (usually stagnant)
100°F, 15 psia

Applies to BNL Part #s with prefix ECCS-RWSTHDR
9,11,12,18,39,40,42,55

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	High	Not likely at these low temperatures.	
4	Low	High	High	SCC unlikely at this low temperature where there is little possibility of contamination	
5	Low	High	High	Need oxidants and/or corrosive impurities to be present	
6	Low	High	High	Unlikely in the absence of a chemistry problem	Management of ECCS coolant chemistry
7	Medium	Medium	Medium	High cycle ripple loading SCC.Difficult for inspection before leak.	Ripple loading
8	Low	High	High	SCC could occur, but expect much more dominant effect of fatigue.	

Subgroup **15.1**

All stainless steel components
External surfaces
Auxiliary building air
Ambient, 15 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
1-57

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	High	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **15.1**

All stainless steel components
External surfaces
Auxiliary building air
Ambient, 15 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
1-57

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Medium	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **15.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
6,31

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **15.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
6,31

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Availability of sulfate and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **15.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
6,31

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	Cold work and temperature
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	

Subgroup **15.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
3,4,6,8,13,16,19,22,27,29,31,34,40,48,57

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **15.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
3,4,6,8,13,16,19,22,27,29,31,34,40,48,57

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients. However, in upper range of this subgroup microbes might not be viable.	
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **15.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
3,4,6,8,13,16,19,22,27,29,31,34,40,48,57

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Some field cracking due to SCC - presumably chloride contamination, or to critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **15.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
1,2,5,6,7,9,10,11,12,14,15,17,18,20,21,23,24,25,26,28,30,31,32,33,35,36,37,38,39,41,42,43,44,45,46,47,49,50,51,52,53,54,55,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **15.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
1,2,5,6,7,9,10,11,12,14,15,17,18,20,21,23,24,25,26,28,30,31,32,33,35,36,37,38,39,41,42,43,44,45,46,47,49,50,51,52,53,54,55,56

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **15.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
1,2,5,6,7,9,10,11,12,14,15,17,18,20,21,23,24,25,26,28,30,31,32,33,35,36,37,38,39,41,42,43,44,45,46,47,49,50,51,52,53,54,55,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium	Very limited problem at <200F	

Subgroup **15.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
3,4,8,13,16,19,22,27,29,34,40,48,57

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **15.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
3,4,8,13,16,19,22,27,29,34,40,48,57

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Availability of sulfate and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **15.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
3,4,8,13,16,19,22,27,29,34,40,48,57

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Very limited problem at <200F	

Subgroup **15.6**

Socket welds
Type 304, Borated demin water
100-200°F, 15-50 psia

Applies to BNL Part #s with prefix ECCS-CVPMPS
<1 inch instrumentation piping and access plugs

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **16.1**

All stainless steel components
External surfaces
Auxiliary building air
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
1-48
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	Pits may initiate cracks/pits occur under surface deposits	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **16.1**

All stainless steel components
External surfaces
Auxiliary building air
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
1-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **16.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
2,16
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **16.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
2,16
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Availability of microbes and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **16.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
2,16
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	unlikely at these temperatures	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **16.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
2,4,7,9,12,14,16,18,22,24,28,34,40,44,48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Temperature too low. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **16.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
2,4,7,9,12,14,16,18,22,24,28,34,40,44,48

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Available microbes and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **16.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
2,4,7,9,12,14,16,18,22,24,28,34,40,44,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	Temperature too low. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Some field cracking due to SCC - presumably chloride contamination, or to critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Low	High	High	Low temperature presumably precludes chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **16.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
1,2,3,5,6,8,10,11,13,15,16,17,19,20,21,23,25,26,27,29,30,31,32,33,35,36,37,38,39,41,42,43, 45,46,47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials.	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **16.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
1,2,3,5,6,8,10,11,13,15,16,17,19,20,21,23,25,26,27,29,30,31,32,33,35,36,37,38,39,41,42,43,45,46,47

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Available microbes and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **16.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
1,2,3,5,6,8,10,11,13,15,16,17,19,20,21,23,25,26,27,29,30,31,32,33,35,36,37,38,39,41,42,43, 45,46,47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Low	High	High	unlikely at these temperatures	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	Medium	Medium	Very limited problem at <100F	

Subgroup **16.5**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
4,7,9,12,14,18,22,24,28,34,40,44,48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **16.5**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
4,7,9,12,14,18,22,24,28,34,40,44,48

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **16.5**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
4,7,9,12,14,18,22,24,28,34,40,44,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	unlikely at these temperatures	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	Medium	Very limited problem at <100F	

Subgroup **16.6**

Socket welds
Type 304
Borated demin water (normally stagnant)
Ambient, 15-100 psia

Applies to BNL Part #s with prefix ECCS-SIPMPS
<1 inch instrumentation piping and access plugs

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	High	Medium	Assume lab data base for wrought materials applies.	
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **17.1**

All stainless steel components
External surfaces
Auxiliary building air
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
1-77

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	Pits may initiate cracks/pits occur under surface deposits	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **17.1**

All stainless steel components
External surfaces
Auxiliary building air
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
1-77

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **17.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
20,46,53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Medium	Medium	Low	Vibration most likely comes from the pump with high frequency. This frequency would be less aggressive to corrosion fatigue. Perhaps some aggressiveness to ripple loading for SCC. Upper temperature range would accelerate corrosion fatigue contributions.	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **17.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
20,46,53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Good performance in the field. Higher temperatures become aggressive in pure water and SCC in pure deoxygenated water is possible. SCC accelerated with cold work and ripple loading. Temperature dependence of these steels in this range is uncertain	Cold work on surface would accelerate initiation.
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	High	Limited problem at <350F	

Subgroup **17.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
6,10,15,18,20,25,35,43,46,53,59,76,77
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Upper part of temperature range might accelerate corrosion fatigue. corrosion fatigue may supply accelerative ripple load	Vibrations superimposed on SCC might accelerate.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **17.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
6,10,15,18,20,25,35,43,46,53,59,76,77

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	SCC occurs in upper part of temperature range Good field experience	No issue here. Surface abuse and cold work
4	Low	High	High	Some field cracking due to SCC - presumably chloride contamination, or to critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **17.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS

1,2,3,4,5,7,8,9,11,12,13,14,16,17,19,20,21,22,23,24,26,27,28,29,30,31,32,33,34,36,37,38,39,40,41,42,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	Only likely to be a problem where present design rules give CUF>0.1approx.
3	Low	High	Medium	Corrosion fatigue stimulates SCC with ripple load although the high frequency may not accelerate much	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **17.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS

1,2,3,4,5,7,8,9,11,12,13,14,16,17,19,20,21,22,23,24,26,27,28,29,30,31,32,33,34,36,37,38,39,40,41,42,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	SCC may be significant in the upper temperature range	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited problem at <350F	

Subgroup **17.5**

Cast austenitics
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
76

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	Medium	Medium	May be affected by variations in metallurgy and discontinuities in casting	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Medium	High	High	Known issue	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **17.5**

Cast austenitics
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
76

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Temperature too low for any significant thermal aging	
2	Low	High	Medium	Well characterized, but not in environment. More likely at higher temperatures.	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	The aging of cast stainless steels produces uncertainties but the fracture resistance is lowered. It is not clear how this issue is a problem for longer times. No sense of statistical distribution of fracture resistance with metallurgical variables	Most likely incided when defects are present. Possible pitting due to metallurgical defects.
4	Low	High	Medium	Well known issue Susc score 1 to reflect low temperature and therefore effect on aging kinetics. Lower Knowledge score to reflect uncertainty of compositional effects (see CASS topical)	
5	--	Low	Low		
6	Low	High	High	Well characterized phenomenon	Known issue. Effective prediction models. Probably not enough degradation to be significant in service
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium		

Subgroup **17.5**

Cast austenitics
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
76

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in cast duplex SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
4	Low	Low	Low	Sufficient doubts to initiate testing program in Europe, but low T gives low susc. score	
5	Medium	Low	Low	Sufficient doubts to initiate testing program in Europe	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	Low	Low	Lower temperature makes aging effects inconsequential to non-existent	

Subgroup **17.6**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
6, 10, 15, 18, 25, 35, 43, 59, 77
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Assume data base for wrought materials applies. Higher end of temperature range may be more sensitive to corrosion fatigue. corrosion fatigue more likely to provide ripple on the SCC depending on the cyclic frequency.	low cyclic frequencies
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **17.6**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
6, 10, 15, 18, 25, 35, 43, 59, 77

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Cold work, surface abuse
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited problem at <350F	

Subgroup **17.7**

Socket welds
Type 304
Borated demin water (normally stagnant)
Ambient, <100 psia

Applies to BNL Part #s with prefix ECCS-RHPMPS
<1 inch instrumentation piping and access plugs

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field but the effect of temperature on failures is not clear	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **18.1**

All stainless steel components
External surfaces
Containment air
100°F to 150°F, 640 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-ACCM
1-41
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	Pits may initiate cracks/pits occur under surface deposits	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **18.1**

All stainless steel components
External surfaces
Containment air
100°F to 150°F, 640 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-ACCM
1-41
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **18.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2,5,17,35
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	Only likely to be a problem where flow induced vibration occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **18.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2,5,17,35
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Availability of sulfate and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **18.2**

Wrought austenitic stainless steel piping
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2,5,17,35
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High		

Subgroup **18.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1,2,5,9,12,15,17,20,24,27,35,38
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Temperature too low. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **18.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1,2,5,9,12,15,17,20,24,27,35,38
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	MIC organisms available
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **18.3**

Austenitic weld HAZs
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1,2,5,9,12,15,17,20,24,27,35,38
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	Temperature too low. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Some field cracking due to SCC - presumably chloride contamination, or to critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **18.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2,3,4,5,6,7,8,10,11,13,14,16,18,19,21,22,23,25,26,34,36,37,39,40,41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use or, in the case of parts 25 and 26 particularly and the pipe in between , thermal fatigue due to minor leaks past the isolation valve.
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use or, in the case of parts 25 and 26 particularly and the pipe in between , thermal fatigue due to minor leaks past the isolation valve.
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use or, in the case of parts 25 and 26 particularly and the pipe in between , thermal fatigue due to minor leaks past the isolation valve.
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use or, in the case of parts 25 and 26 particularly and the pipe in between , thermal fatigue due to minor leaks past the isolation valve.
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use or, in the case of parts 25 and 26 particularly and the pipe in between , thermal fatigue due to minor leaks past the isolation valve.

Subgroup **18.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2,3,4,5,6,7,8,10,11,13,14,16,18,19,21,22,23,25,26,34,36,37,39,40,41
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	MIC organisms available
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **18.4**

Austenitic to austenitic weld metals
Type 308
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2,3,4,5,6,7,8,10,11,13,14,16,18,19,21,22,23,25,26,34,36,37,39,40,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	Medium		

Group **18** **Emergency Core Cooling Systems**

Accumulator Piping to RCS Cold Leg

Subgroup **18.5**

Dissimilar metal welds
Type 308, 309, Alloys 82, 182
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt a significant data base exists	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	Medium	Medium	Probably not a serious problem in fatigue	
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Low	Medium	Medium	Doubt a significant data base exists	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	Medium	Medium	Doubt a significant data base exists	Only likely to be a problem where flow induced vibration occurs during use
8	Low	Medium	Medium	Doubt a significant data base exists	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **18.5**

Dissimilar metal welds
Type 308, 309, Alloys 82, 182
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Temperature too low for any significant thermal aging of stainless weld metal. Not an issue for nickel base weld metals.	
2	Low	High	Medium	Well characterized, but not in environment. More likely at higher temperatures.	Known issue. Effective prediction models based on air data.
3	Low	Medium	Medium	This is range of temperature for Mills effect to become serious	Defect at surface, abused surface, cold work
4	Low	Low	Low		
5	--	Low	Low		
6	Low	Low	Low	A form of fracture resistance degradation, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals	It's not clear if the conditions required for LTCP in lab tests are met in PWR service. The likelihood appears greatest during cooldown.
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Medium	Medium	Medium		

Subgroup **18.5**

Dissimilar metal welds
Type 308, 309, Alloys 82, 182
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Low	Low	Need low flow. This is right range of temperature, need microbes and nutrients	Microbes, nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Group **18** **Emergency Core Cooling Systems**

Accumulator Piping to RCS Cold Leg

Subgroup **18.5**

Dissimilar metal welds
Type 308, 309, Alloys 82, 182
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Dilution zone with carbon or low alloy steel potentially vulnerable, especially in the case of too high heat at interface with the risk of martensite formation and sensitization of the austenite.	Impurities and dissolved oxygen
2	Medium	High	Medium	Generic issue for alloys 82/182.	Less likely to a problem than at higher temperatures
3	Low	Medium	Medium	Temp in low range for SCC	Abused surface, cold work
4	0	High	High	Not likely for delta ferrite welds at these low temps and low potential environment	
5	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
6	Low	High	High	Very good field experience to date for austenitic weld metals due. Alloys 182/82 are susceptible to LTCP which is covered under FR	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Medium	Medium	Medium	Possible degradation mechanism even at these low temperature when the materials are cold worked or weld strained to certain level of yield strength.	
8	Low	High	Medium	Concerned for dilution zone in CS or LAS	

Subgroup **18.6**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
9, 12, 15, 20, 24, 27, 38
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **18.6**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
9, 12, 15, 20, 24, 27, 38
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	MIC organisms available
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	High	High	if bacteria and deposits present, can occur	periodic flushing of lines a concern
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients

Subgroup **18.6**

Forged austenitic stainless steel nozzles
Types 304, 316
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
9, 12, 15, 20, 24, 27, 38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Abused surfaces, high cold work, high residual stresses
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	Medium	Very limited concern at <150F	

Subgroup **18.7**

Socket welds
Type 304
Borated demin water (normally stagnant)
100°F to 150°F, 640 psia

Applies to BNL Part #s with prefix ECCS-ACCM
2" branch lines and <1 inch instrumentation piping and access plugs
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **18.8**

Dissimilar metal welds
Type 308, 309, Alloys 82/182
External surface

Applies to BNL Part #s with prefix ECCS-ACCM
1

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization. Joints with stainless steel are more susceptible	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
2	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization. Joints with stainless steel are more susceptible	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
3	Low	Medium	Medium	Not much data. Low temp for SCC	
4	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization. Joints with stainless steel are more susceptible	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
5	Low	High	High	Possible if weld sensitized and highly stressed and subjected to a corrosive environment, but unlikely here	
6	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization. Joints with stainless steel are more susceptible	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
7	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization. Joints with stainless steel are more susceptible	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.
8	Medium	High	Medium	External cracking a known issue in dilution zone with low alloy steel leading to sensitization. Joints with stainless steel are more susceptible	This cracking can occur prior to service either during stress relief in natural gas fired furnaces or due to exposure to salt atmospheres.

Subgroup **18.9**

All stainless steel components
External surfaces when at <150C
Containment air, Normally dry when at low temp
600°F, 2250 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-ACCM
1-41

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness	Exposure to wetness
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **18.9**

All stainless steel components
External surfaces when at <150C
Containment air, Normally dry when at low temp
600°F, 2250 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-ACCM
1-41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
3	Low	High	High	While SS can sustain SCC and pitting readily the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained water or if the surface was warm enough to evaporate water. Surface abuse might stimulate
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **18.10.1**

Austenitic weld HAZs
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
30

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Higher temperature might accelerate corrosion fatigue.	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **18.10.1**

Austenitic weld HAZs
Type 304, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
30

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Higher temperature may accelerate	Special surface conditions on welds.
4	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	High	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **18.10.2**

Austenitic weld HAZs
Type 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
30

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Higher temperature might accelerate corrosion fatigue.	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **18.10.2** Austenitic weld HAZs
Type 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
30
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Higher temperature may accelerate	Special surface conditions on welds.
4	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	High	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **18.11**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
28,29,31,32,33

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Effect of higher temperature not clear	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **18.11**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
28,29,31,32,33

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment. More likely at higher temperatures.	Known issue. Effective prediction models based on air data.
3	Low	Medium	Low	The Mills effect seems to apply less at high temperature than at lower temperatures. However, this effect has not really been adequately explored with respect to alloys and temperature. Higher temperature might diminish effect but not clear	Not clear what to say since the domains of the phenomenon are not clear
4	0	High	Medium	Unknown mechanism of embrittlement in this alloy/component system	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium		

Subgroup **18.11**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
28,29,31,32,33

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	Low	Very good field experience, no data	
3	Low	Medium	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Higher temperature may accelerate	Special surface conditions on welds.
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	HAZ is a bigger concern, but aging of weld metals may create a problem. Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **18.12**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
30

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Medium	Medium	Low	Surface finish a known problem + possible environmental effects. Uncertain evaluation of thermal eddies and impact on strain amplitude values	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **18.12**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
600°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-ACCM
30

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite.	Longer times, surface dings and dents.
4	Medium	Medium	Medium		
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Very good field experience to date -- no known cracking in austenitic welds due to SCC	Not anticipated to be a problem due to low ECP under nominal operating conditions
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium		

Subgroup **18.13**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix ECCS-ACCM
for CE and B&W plants

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for fixturing or lack of fixturing. Residual stresses superimposed.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Possible environmental effects and dissimilar expansion coefficients could lead to corrosion fatigue under thermal cycling	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	High	Medium		

Subgroup **18.13**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix ECCS-ACCM
for CE and B&W plants

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Stainless steel welds not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Known isssue for nickel base welds (Susceptibility increases to 2).	Known issue. Effective prediction models. For nickel-based welds, microstructure and carbide morphology.
2	Low	Medium	Medium	Hypothetical under these conditions but has not been studied sufficiently to eliminate.	
3	Low	Medium	Medium	Concern is mainly with low temperature. Good field performance. Data for FR at high temperature is not convincing	
4	Medium	Medium	Medium	Intermediate scores for SCK due to unclear definition of system. FR possible for 308 if ferrite is abnormally high after extended operating times. FR of 82/182 might be possible under dynamic loading conditions during transient operating conditions when temperature is lowered. In both cases there is uncertainty due to lack of FR data in the environment.	
5	Low	High	High	182 may be more susceptible; otherwise highly stressed welds an issue	
6	Low	Low	Low	A form of fracture resistance, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals. I'm not aware of any compelling evidence that stainless steel weld metals are subject to reduction of fracture resistance under plant-relevant conditions	It's not clear that the conditions required for LTCP of nickel-base alloys and weld metals in lab tests exist in PWR service. Lab testing is needed to explore whether significant reduction of fracture resistance occurs under plant-relevant conditions for Types 308/309 stainless steel weld metals
7	Medium	Medium	Medium	Thermal aging reduces a fracture resistance in 308/309 and also reduction in J-R curves in alloys 82/182 under monotonically increasing loading.	Spinodal decomposition for duplex microsructure and SCC occurance under rising load in PWR
8	Medium	High	High		

Subgroup **18.13**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix ECCS-ACCM
for CE and B&W plants

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Alloys 82/182 weld metals present a significant risk of SCC at this temperature after extended exposure (~20 years) to primary water. Stainless steel weld metals exposed to primary water have very good service experience and would be marked 1,3,3	Extended exposure time for the nickel base weld metals
2	High	High	Medium	Generic issue for alloys 82/182.	
3	Medium	High	Low	Not aware of significant information on initiation and propagation. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite.	Special surface conditions on welds.
4	High	High	Low	IGSCC in PWR primary water a generic issue for alloys 600/82/182 only. Lower value for "knowledge" reflects life management concerns following VC Summer hot leg and VHP incidents. We have poor predictive capabilities for e.g. composition effects and little assurance that mitigation actions associated with 690/152/52 will be fully effective. "good" experience with replacement SG tubes not necessarily relevant. Poor specs for welding procedures for these high Cr alloys.	
5	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
6	High	High	Medium	Score given are for Alloys 82/182 for which SCC in primary-type water is a generic issue. Scores for Types 308/308 would be lower on susceptibility and higher on knowledge	Variables affecting SCC of Alloys 82/182 are not completely understood at this point. SCC of Types 308/309 is not expected to be a problem under nominal operating conditions
7	Medium	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Medium	High	Medium	Concern for dilution zone in CS or LAS	

Group **19** **Emergency Core Cooling Systems** **SI/RHR Piping to RCS/ HL Leg**

Subgroup **19.1**

All stainless steel components
External surfaces
Containment/ Auxiliary buidling air
100°F to 350°F, 15 to 400 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-HLCONN
1-58
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	only low T portions at risk if wet chlorides can deposit on surfaces	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.1**

All stainless steel components
External surfaces
Containment/ Auxiliary buidling air
100°F to 350°F, 15 to 400 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-HLCONN
1-58

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
2,12,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Medium	Medium	Low	Vibration most likely comes from the pump with high frequency. This frequency would be less aggressive to corrosion fatigue. Perhaps some aggressiveness to ripple loading for SCC. Upper temperature range would accelerate corrosion fatigue contributions.	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Flow induced vibration seems to be the only fatigue risk	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
2,12,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Higher temperatures become aggressive in pure water and SCC in pure deoxygenated water is possible. SCC accelerated with cold work and ripple loading	Cold work on surface would accelerate initiation.
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	Very good field experience and not anticipated to be a long term problem.
8	Low	High	High	Limited concern at <350F	

Subgroup **19.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
2,4,7,10,12,16,18,20,37,41,53,54,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Upper part of temperature range might accelerate corrosion fatigue. corrosion fatigue may supply accelerative ripple load	Vibrations superimposed on SCC might accelerate.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Flow induced vibration seems to be the only fatigue risk	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **19.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
2,4,7,10,12,16,18,20,37,41,53,54,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	SCC occurs in upper part of temperature range Good field experience	No issue here. Surface abuse and cold work
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN

1,3,5,6,8,9,11,13,14,15,17,19,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,38,39,40,42,43,44,45,46,47,48,49,50,51,52,55,57,58

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Corrosion fatigue stimulates SCC with ripple load although the high frequency may not accelerate much	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN

1,3,5,6,8,9,11,13,14,15,17,19,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,38,39,40,42,43,44,45,46,47,48,49,50,51,52,55,57,58

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	SCC may be significant in the upper temperature range	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
8	Low	High	High	Limited concern at <350F	

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
4,7,10,16,18,22,37,41,53,54,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Low	High	Medium	Assume lab data base for wrought materials applies. Higher end of temperature range may be more sensitive to corrosion fatigue. corrosion fatigue more likely to provide ripple on the SCC depending on the cyclic frequency.	low cyclic frequencies
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **19.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
4,7,10,16,18,22,37,41,53,54,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Cold work, surface abuse
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
8	Low	High	High	Limited concern at <350F	

Subgroup **19.6**

Socket welds
Type 304, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
13

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	0	High	Medium	No known loading issues, normally stagnant lines.	
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **19.6**

Socket welds
Type 304, Borated demin water (normally stagnant)
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
13

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Medium	Medium	High	Failures in field exacerbated by corrosion fatigue. Lower rate than higher temperatures	Vibration and bending stresses exacerbated by residual stresses on possibly surface abuse.
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	
5	Low	High	High	possible if high stresses or cold work present	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
8	Medium	High	Medium	Includes HAZ, so SCC is a concern -- but corrosion fatigue will probably dominate	

Group **19** **Emergency Core Cooling Systems** **SI/RHR Piping to RCS Hot Leg**

Subgroup **19.7**

All stainless steel components
External surfaces when at <150C
Containment air (Normally dry when at low temp)
600°F , 2250 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness	Exposure to wetness
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.7**

All stainless steel components
External surfaces when at <150C
Containment air (Normally dry when at low temp)
600°F , 2250 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained water or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Unlikely if surfaces uncontaminated or remain dry (possibly wet only under off-power conditions). Most likely for outside components. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **19.8.1**

Austenitic weld HAZs
Type 304, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.8.1**

Austenitic weld HAZs
Type 304, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Medium	High	Medium	Good field experience to date, however sensitized 304 has been reported with SCC in regions where oxygen can be trapped during refueling. The material is inherently susceptible, and has been found to crack and propagate under low potential regimes in BWRs.	Cold work from surface grinding and weld repairs will exacerbate the problem. Both are often undocumented in the manufacturing procedures. No known lab data of specific propagation rates.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	High	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	Medium	Medium	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **19.8.2**

Austenitic weld HAZs
Type 316, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Low	Medium	Medium	Lab data base is not as good as for wrought materials. Very good field experience so far.	Deoxygenated water effects on corrosion fatigue of austenitic materials a known issue.
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 3, 27
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **19.8.2**

Austenitic weld HAZs
Type 316, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Under most circumstances 316 of the manufacturing generation has been found to be less susceptible than 304.	The occurrence of heavy grinding could however be an important factor.
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Other workers have shown the same. However, there is not a coherent view on the critical dependencies. In addition, the presence of residual stresses from the adjacent produces magnitudes of stress beyond any design stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	High	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	Medium	Medium	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
7	Low	High	High	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **19.9**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue, e.g. parts 1, 2, 11, 12, 28
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **19.9**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Medium	Medium	Medium	FR can be lower after low temperature aging (LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium	Concern for aging and in-situ FR	

Subgroup **19.9**

Austenitic to austenitic weld metals
Type 308, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	Low	Very good field experience, no data	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	High	Very good field experience - no known cracking due to SCC - negligible dissolved oxygen	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	Medium	Medium	Very good field experience - no known cracking due to IGSCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	Medium	Medium	HAZ is a bigger concern, but aging of weld metals may create a problem. Ferrite containing weld metals can crack in the lab, but the growth rates are not that high. Aging may increase susceptibility, but probably only if ferrite levels are high (e.g., >12-15%)	

Subgroup **19.10**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F , 2250 psia
For CE and B&W plants
Covered in RCS groups

Applies to BNL Part #s with prefix ECCS-HLCONN
28,48
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Medium	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, the 82/182 group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The 300 group should behave about as the 300 series wrought materials. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Possible environmental effects and dissimilar expansion coefficients could lead to corrosion fatigue under thermal cycling	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Effects of LT aging is not clear.
8	Medium	Medium	Medium	More concern for environmental effect at low potential on 308/309, but corrosion fatigue could accelerate initiation and growth in 182/82	

Group **19** **Emergency Core Cooling Systems**

SI/RHR Piping to RCS Hot Leg

Subgroup **19.10**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F , 2250 psia
For CE and B&W plants
Covered in RCS groups

Applies to BNL Part #s with prefix ECCS-HLCONN
28,48

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Stainless steel welds not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Known isssue for nickel base welds (Susceptibility increases to 2).	Known issue. Effective prediction models. For nickel-based welds, microstructure and carbide morphology.
2	Low	Medium	Medium	Hypothetical under these conditions but has not been studied sufficiently to eliminate.	
3	Low	Medium	Medium	Concern is mainly with low temperature. Good field performance. Data for FR at high temperature is not convincing	
4	Medium	Medium	Medium	Intermediate scores for SCK due to unclear definition of system. FR possible for 308 if ferrite is abnormally high after extended operating times. FR of 82/182 might be possible under dynamic loading conditions during transient operating conditions when temperature is lowered. In both cases there is uncertainty due to lack of FR data in the environment.	
5	Low	Medium	Medium	182 may be more susceptible; otherwise highly stressed welds an issue	
6	Low	Low	Low	A form of fracture resistance, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals. I'm not aware of any compelling evidence that stainless steel weld metals are subject to reduction of fracture resistance under plant-relevant conditions	It's not clear that the conditions required for LTCP of nickel-base alloys and weld metals in lab tests exist in PWR service. Lab testing is needed to explore whether significant reduction of fracture resistance occurs under plant-relevant conditions for Types 308/309 stainless steel weld metals
7	Medium	Medium	Medium	Thermal aging reduces a fracture resistance in 308/309 and also reduction in J-R curves in alloys 82/182 under monotonically increasing loading.	Spinodal decomposition for duplex microsructure and SCC occurance under rising load in PWR
8	Medium	High	High		

Subgroup **19.10**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F , 2250 psia
For CE and B&W plants
Covered in RCS groups

Applies to BNL Part #s with prefix ECCS-HLCONN
28,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Alloys 82/182 weld metals present a significant risk of SCC at this temperature after extended exposure (~20 years) to primary water. Stainless steel weld metals exposed to primary water have very good service experience and would be marked 1,3,3	Extended exposure time for the nickel base weld metals
2	High	High	Medium	Generic issue for alloys 82/182.	
3	High	High	High	It's not clear whether these are exposed to the water. Assuming that they are, the 82/182 group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	High	High	Low	IGSCC in PWR primary water a generic issue for alloys 600/82/182 only. Lower value for "knowledge" reflects life management concerns following VC Summer hot leg and VHP incidents. We have poor predictive capabilities for e.g. composition effects and little assurance that mitigation actions associated with 690/152/52 will be fully effective. "good" experience with replacement SG tubes not necessarily relevant. Poor specs for welding procedures for these high Cr alloys.	
5	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
6	High	High	Medium	Score given are for Alloys 82/182 for which SCC in primary-type water is a generic issue. Scores for Types 308/308 would be lower on susceptibility and higher on knowledge	Variables affecting SCC of Alloys 82/182 are not completely understood at this point. SCC of Types 308/309 is not expected to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	High	High	Medium	Concern for 82/182	

Subgroup **19.11**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Medium	Medium	Low	Surface finish a known problem + possible environmental effects. Uncertain evaluation of thermal eddies and impact on strain amplitude values	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
7	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
8	Medium	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where present nominal CUF>0.1approx. Dead legs close to main coolant line potentially vulnerable to thermal fatigue.

Subgroup **19.11**

Forged austenitic stainless steel nozzles
Types 304, 316, PWR primary water
600°F , 2250 psia

Applies to BNL Part #s with prefix ECCS-HLCONN
19-28,46-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times and effects of possible grinding cannot be ignored. May be able to use forged data	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions, including machining, on surfaces. Further, austenitic stainless steels are not stable with respect to forming ferrite through an intermediate martensite. This transformation may occur at grain boundaries and at second phase boundaries as well as in the matrix. These transformations affect slip focusing on planes, stacking fault energy, stresses at dislocation pile ups.	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Medium	Medium	Medium		
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	Medium	Medium	Very good field experience to date	not expected to be a problem under nominal operating conditions
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Some concern, but more for cold worked or HAZ SS	

Subgroup **20.1**

All stainless steel components
External surfaces
Auxiliary building air
100°F to 350°F, 15 to 400 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-RHPMPD
1-54
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	Pits may initiate cracks/pits occur under surface deposits on cooler parts	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **20.1**

All stainless steel components
External surfaces
Auxiliary building air
100°F to 350°F, 15 to 400 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-RHPMPD
1-54
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **20.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
7

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Medium	Medium	Low	Vibration most likely comes from the pump with high frequency. This frequency would be less aggressive to corrosion fatigue. Perhaps some aggressiveness to ripple loading for SCC. Upper temperature range would accelerate corrosion fatigue contributions.	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **20.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
7

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Higher temperatures become aggressive in pure water and SCC in pure deoxygenated water is possible. SCC accelerated with cold work and ripple loading	Cold work on surface would accelerate initiation.
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	High	Limited concern at <350F	

Subgroup **20.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
4,7,11,14,16,18,21,23,27,28,30,33,42,44,47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Upper part of temperature range might accelerate corrosion fatigue. corrosion fatigue may supply accelerative ripple load	Vibrations superimposed on SCC might accelerate.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **20.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
4,7,11,14,16,18,21,23,27,28,30,33,42,44,47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	SCC occurs in upper part of temperature range Good field experience	No issue here. Surface abuse and cold work
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Low	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades). Less concern at <350F	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **20.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD

1,2,3,5,6,7,8,9,10,12,13,15,17,18,19,20,22,24,25,26,28,29,31,32,34,35,36,37,38,39,40,41,43,45,46,48,49,50,51,52

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Corrosion fatigue stimulates SCC with ripple load although the high frequency may not accelerate much	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **20.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD

1,2,3,5,6,7,8,9,10,12,13,15,17,18,19,20,22,24,25,26,28,29,31,32,34,35,36,37,38,39,40,41,43,45,46,48,49,50,51,52

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	SCC may be significant in the upper temperature range	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited concern at <350F	

Subgroup **20.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
4,11,14,16,21,23,27,30,33,42,44,47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Assume lab data base for wrought materials applies. Higher end of temperature range may be more sensitive to corrosion fatigue. corrosion fatigue more likely to provide ripple on the SCC depending on the cyclic frequency.	low cyclic frequencies
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **20.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
4,11,14,16,21,23,27,30,33,42,44,47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Cold work, surface abuse
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited concern at <350F	

Subgroup **20.6**

Socket welds
Type 304, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
2" branch lines and <1 inch instrumentation piping and access plugs

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Group
20

Emergency Core Cooling Systems

RHR Pump Discharge Piping

App.E.4 - All PWR Scores

Subgroup
20.6

Socket welds
Type 304, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHPMPD
2" branch lines and <1 inch instrumentation piping and access plugs

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	In lower end of range for SCC. Accelerated by abused surfaces, cold work, sharp corners.	
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	
5	Low	High	High	possible if high stresses or cold work present	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Theoretical concern. Possibly synergy with high R fatigue.	
8	Medium	High	High	Includes HAZ, so SCC is a concern, but not much as <350F -- corrosion fatigue will probably dominate	

Subgroup **21.1**

All stainless steel components
External surfaces
Auxiliary buidling air
100°F to 350°F, 15 to 400 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-RHRCL
1-30
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	Only if cool surfaces condense Cl-contaminates	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **21.1**

All stainless steel components
External surfaces
Auxiliary buidling air
100°F to 350°F, 15 to 400 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-RHRCL
1-30
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **21.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Medium	Medium	Low	Vibration most likely comes from the pump with high frequency. This frequency would be less aggressive to corrosion fatigue. Perhaps some aggressiveness to ripple loading for SCC. Upper temperature range would accelerate corrosion fatigue contributions.	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **21.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Higher temperatures become aggressive in pure water and SCC in pure deoxygenated water is possible. SCC accelerated with cold work and ripple loading	Cold work on surface would accelerate initiation.
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	High	Limited concert at <350F	

Subgroup **21.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
2,6,9,12,18,20,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Upper part of temperature range might accelerate corrosion fatigue. corrosion fatigue may supply accelerative ripple load	Vibrations superimposed on SCC might accelerate.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **21.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
2,6,9,12,18,20,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	SCC occurs in upper part of temperature range Good field experience	No issue here. Surface abuse and cold work
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **21.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
1,3,4,5,6,7,8,10,11,13,14,15,16,17,19,21,22,23,24,25,2728,29,30

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Corrosion fatigue stimulates SCC with ripple load although the high frequency may not accelerate much	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **21.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
1,3,4,5,6,7,8,10,11,13,14,15,16,17,19,21,22,23,24,25,2728,29,30

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	SCC may be significant in the upper temperature range	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited concert at <350F	

Subgroup **21.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
2,9,12,18,20,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Assume lab data base for wrought materials applies. Higher end of temperature range may be more sensitive to corrosion fatigue. corrosion fatigue more likely to provide ripple on the SCC depending on the cyclic frequency.	low cyclic frequencies
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **21.5**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
2,9,12,18,20,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Cold work, surface abuse
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Cold worked 300 SS can show IGSCC in PWR but temperature is low.	
8	Low	High	High	Limited concert at <350F	

Subgroup **21.6**

Socket welds
Type 304, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
24

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **21.6**

Socket welds
Type 304, Borated demin water
100°F to 350°F, 15 to 400 psia

Applies to BNL Part #s with prefix ECCS-RHRCL
24

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	In lower end of range for SCC. Accelerated by abused surfaces, cold work, sharp corners.	
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	
5	Low	High	High	possible if high stresses or cold work present	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Theoretical concern. Possibly synergy with high R fatigue.	
8	Medium	High	High	Includes HAZ, so SCC is a concern -- but corrosion fatigue will probably dominate	

Subgroup **22.1**

All stainless steel components
External surfaces
Containment/Auxiliary building air
200°F, 2250 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-CVCL
1-86
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	
5	Medium	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation. Pits can initiate cracks	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **22.1**

All stainless steel components
External surfaces
Containment/Auxiliary building air
200°F, 2250 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-CVCL
1-86

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Cl from insulation or atmospheric aerosols - concern if wetted. Tolerance level depends on alkali buffer from insulation.	
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Subgroup **22.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
10,22,43,53,64

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	Only likely to be a problem where flow induced vibration occurs during use
5	Medium	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **22.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
10,22,43,53,64

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited concern at <200F	

Subgroup **22.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
3,8,10,12,14,19,22,24,27,29,30,33,37,41,43,53,64,66,69,84

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Temperature too low. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **22.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
3,8,10,12,14,19,22,24,27,29,30,33,37,41,43,53,64,66,69,84

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	Temperature too low. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Group **22** **Emergency Core Cooling Systems** **CVCS Piping to RCS Cold Leg**

Subgroup **22.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL

1,2,4,5,6,7,9,11,13,15,16,17,18,20,21,23,25,26,28,31,32,34,35,36,38,39,40,42,44,45,46,47,48,49, 50,51,52,54,55,56,57,58,59,60,61,62,63,65,67,68,70,71,72,73,74,75,76,77,78,79,80,83,84,85,86

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **22.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL

1,2,4,5,6,7,9,11,13,15,16,17,18,20,21,23,25,26,28,31,32,34,35,36,38,39,40,42,44,45,46,47,48,49,50,51,52,54,55,56,57,58,59,60,61,62,63,65,67,68,70,71,72,73,74,75,76,77,78,79,80,83,84,85,86

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	Limited concern at <200F	

Subgroup **22.5**

Austenitic to austenitic weld metals
Type 308, PWR primary water
560°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
80,81,82,83

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx.
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx.
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx.
8	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx.

Subgroup **22.5**

Austenitic to austenitic weld metals
Type 308, PWR primary water
560°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
80,81,82,83

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	Medium	Well characterized, but not in environment	Known issue. Effective prediction models based on air data.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy, orientation	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Don't see a major problem for this failure mechanism, given the low ferrite content	
5	--	Low	Low		
6	Low	Medium	Medium	Not aware of any compelling evidence that stainless weld metals are subject to significant fracture resistance degradation under plant-relevant conditions	Laboratory testing is lacking for this hypothetical degradation mechanism
7	Low	High	High	FR can be reduced by LTA in ferrite	Spinodal decomposition
8	Low	Medium	Medium	Concern for aging and in-situ FR response	

Subgroup **22.5**

Austenitic to austenitic weld metals
Type 308, PWR primary water
560°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
80,81,82,83

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	Low	Very good field experience, no data	
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC seems to be slow but finite. These results suggest reasonable patterns for weld materials but are not adequate by themselves.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	High	Not likely for high delta ferrite welds at low effective potentials	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	Medium	Medium	Generally good field experience in primary water to date	Not anticipated to be a significant general problem under nominal operating conditions
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	Medium	More concerned for HAZ and cold worked SS, but weld metals can crack	

Subgroup **22.6**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
3,8,12,14,19,24,27,29,30,33,37,41,66,69

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Flow induced vibration seems to be the only fatigue risk	
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **22.6**

Forged austenitic stainless steel nozzles
Types 304, 316, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
3,8,12,14,19,24,27,29,30,33,37,41,66,69

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Abused surfaces, high cold work, high residual stresses
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Medium	High	High	Some field cracking due to SCC - presumably chloride contamination	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	SCC susceptibility after low temperature aging (LTA) is not clear.	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Limited concern at <200F	

Subgroup **22.7**

Socket welds
Type 304, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
6,21

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	Medium	Medium		
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **22.7**

Socket welds
Type 304, Borated demin water
200°F, 2250 psia

Applies to BNL Part #s with prefix ECCS-CVCL
6,21

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	In lower end of range for SCC. Accelerated by abused surfaces, cold work, sharp corners.	
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	
5	Low	High	High	possible if high stresses or cold work present	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Theoretical concern. Possibly synergy with high R fatigue.	
8	Medium	High	High	Includes HAZ, so SCC is a concern -- but corrosion fatigue will probably dominate	

Subgroup **22.8**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix ECCS-CVCL
for CE and B&W Plants

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials	Dead legs close to main coolant line potentially vulnerable to thermal fatigue.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Medium	Medium	Medium	It's not clear whether these are exposed to the water. Assuming that they are, 82/182 group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
5	Medium	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	
6	Medium	Medium	Medium	Possible environmental effects and dissimilar expansion coefficients could lead to corrosion fatigue under thermal cycling	Only likely to be a problem where nominal CUF is greater than about 0.1
7	Medium	Medium	Medium	Vibration stress is critical depending upon flow induced vibration.	Fatigue crack initiation depends on lack of tube support and/or adequate stiffness - may be accelerated by prior damage due to corrosion mechanisms
8	Medium	Medium	Medium	Some concern for environmental effects on SS at low potential, but corrosion fatigue can accelerate initiation in 182/82	

Subgroup **22.8**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix ECCS-CVCL
for CE and B&W Plants

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Stainless steel welds not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit. Known isssue for nickel base welds (Susceptibility increases to 2).	Known issue. Effective prediction models. For nickel-based welds, microstructure and carbide morphology.
2	Low	Medium	Medium	Hypothetical under these conditions but has not been studied sufficiently to eliminate.	
3	Low	Medium	Medium	Concern is mainly with low temperature. Good field performance. Data for FR at high temperature is not convincing	
4	Medium	Medium	Medium	Intermediate scores for SCK due to unclear definition of system. FR possible for 308 if ferrite is abnormally high after extended operating times. FR of 82/182 might be possible under dynamic loading conditions during transient operating conditions when temperature is lowered. In both cases there is uncertainty due to lack of FR data in the environment.	
5	Low	Medium	Medium	182 may be more susceptible; otherwise highly stressed welds an issue	
6	Low	Low	Low	A form of fracture resistance, christened LTCP, has been observed in lab tests on nickel-base alloys and weld metals. I'm not aware of any compelling evidence that stainless steel weld metals are subject to reduction of fracture resistance under plant-relevant conditions	It's not clear that the conditions required for LTCP of nickel-base alloys and weld metals in lab tests exist in PWR service. Lab testing is needed to explore whether significant reduction of fracture resistance occurs under plant-relevant conditions for Types 308/309 stainless steel weld metals
7	Medium	Medium	Medium	Thermal aging reduces a fracture resistance in 308/309 and also reduction in J-R curves in alloys 82/182 under monotonically increasing loading.	Spinodal decomposition for duplex microsructure and SCC occurance under rising load in PWR
8	Medium	High	High	More concerned for 182 than 308/309	

Subgroup **22.8**

Dissimilar metal welds (Internal)
Type 308, 309, Alloys 82, 182
PWR primary water, 600°F, 2250 psia
For CE and B&W plants

Applies to BNL Part #s with prefix ECCS-CVCL
for CE and B&W Plants

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	Alloys 82/182 weld metals present a significant risk of SCC at this temperature after extended exposure (~20 years) to primary water. Stainless steel weld metals exposed to primary water have very good service experience and would be marked 1,3,3	Extended exposure time for the nickel base weld metals
2	High	High	Medium	Generic issue for alloys 82/182.	
3	High	High	High	It's not clear whether these are exposed to the water. Assuming that they are, this group of weld metals should be as prone to SCC as Alloy 600 It's not clear that there are sufficient data to conclude that these weld metals will not sustain corrosion fatigue in the residual stresses and stress cycling to which they are exposed. The corrosion fatigue and SCC here seem interconnected	The necessary conditions for corrosion fatigue or SCC are not clear.
4	High	High	Low	IGSCC in PWR primary water a generic issue for alloys 600/82/182 only. Lower value for "knowledge" reflects life management concerns following VC Summer hot leg and VHP incidents. We have poor predictive capabilities for e.g. composition effects and little assurance that mitigation actions associated with 690/152/52 will be fully effective. "good" experience with replacement SG tubes not necessarily relevant. Poor specs for welding procedures for these high Cr alloys.	
5	Medium	High	Low	Known issue in dilution zone with low alloy steel - sensitization	
6	High	High	Medium	Score given are for Alloys 82/182 for which SCC in primary-type water is a generic issue. Scores for Types 308/308 would be lower on susceptibility and higher on knowledge	Variables affecting SCC of Alloys 82/182 are not completely understood at this point. SCC of Types 308/309 is not expected to be a problem under nominal operating conditions
7	High	High	Medium	Generic issue for alloys 82/182 only	Residual stress and temperature
8	High	High	Medium	Concern for 82/182	

Subgroup **23.1**

All stainless steel components
External surfaces
Auxiliary building air
100°F, 1500-1700 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-SIPMPD
1-53
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Silicate buffer / inhibitor

Subgroup **23.1**

All stainless steel components
External surfaces
Auxiliary building air
100°F, 1500-1700 psia (inside condition)

Applies to BNL Part #s with prefix ECCS-SIPMPD
1-53
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation (if not mirror insulation) and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Most likely for outdoor piping/tanks in seaside plants. Potential sources of Cl indoors are insulation and aerosols.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation.
8	Low	High	High	Well known phenomenon. Cl from insulation & ocean aerosols, the latter increasing with time. This is in containment, so the incidence should be lower than other locations.	Concern only if wet. Tolerance level for Cl depends on silicate buffer in insulation

Group **23** **Emergency Core Cooling Systems**

Safety Injection Pump Discharge Piping

Subgroup **23.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
2,4,8,16,21,24,31,47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Flow induced vibration seems to be the only fatigue risk at this low operating temperature	
5	Low	High	High	Likely only in components subject to cyclic stress	Cyclic stresses applied to highly stressed components
6	Low	Medium	Medium	Good lab data base at low temperature	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Assume limited cyclic loading	

Group **23** **Emergency Core Cooling Systems**

Safety Injection Pump Discharge Piping

Subgroup **23.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
2,4,8,16,21,24,31,47

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Availability of microbes and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	
5	Low	Medium	Medium	not much reported for MIC in these systems; seems unlikely here	MIC possible in low T borated systems, but requires deposits/bacteria, nutrients, etc. to be present
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	High	Medium	No food source and B inhibits MIC	

Subgroup **23.2**

Wrought austenitic stainless steel piping
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
2,4,8,16,21,24,31,47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	unlikely; needs high stresses and corrosive environment	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Low	High	High	Limited concern at <100F	

Subgroup **23.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
1,2,4,5,7,8,11,14,16,18,21,22,24,27,29,31,33,35,37,38,42,45,46,47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Temperature too low. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials; hence decrease in knowledge to 2	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Likely only in components subject to cyclic stress	Cyclic stresses applied to highly stressed components
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	High	Flow induced vibration seems to be the only fatigue risk	

Subgroup **23.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
1,2,4,5,7,8,11,14,16,18,21,22,24,27,29,31,33,35,37,38,42,45,46,47

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Available microbes and nutrients
4	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
5	Low	Medium	Medium	not much reported for MIC in these systems; seems unlikely here	MIC can preferentially attack delta ferrite in austenitic weld metal
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	High	Medium	No food source and B inhibits MIC	

Subgroup **23.3**

Austenitic weld HAZs
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
1,2,4,5,7,8,11,14,16,18,21,22,24,27,29,31,33,35,37,38,42,45,46,47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	High	Temperature too low. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Some field cracking due to SCC - presumably chloride contamination, or to critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Low	High	High	Possible based on lab data; not much plant experience	welds
6	Medium	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Good field experience, but lab data clearly highlight concern. No big difference between 304 and 316 (or L grades)	

Subgroup **23.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
1,2,3,4,6,9,10,12,13,15,16,17,19,20,21,23,25,26,28,30,32,34,36,39,40,41,43,44,48,49,50,51,52,53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use or, in the case of parts 25 and 26 particularly and the pipe in between , thermal fatigue due to minor leaks past the isolation valve.
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	High	Likely only in components subject to cyclic stress	Cyclic stresses applied to highly stressed components
6	Low	Medium	Medium	Very good field experience so far but corrosion fatigue of austenitic materials is a known issue.	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where present nominal CUF>0.1 approx.
8	Low	High	High	Assume limited cyclic loading	

Subgroup **23.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
1,2,3,4,6,9,10,12,13,15,16,17,19,20,21,23,25,26,28,30,32,34,36,39,40,41,43,44,48,49,50,51,52,53

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Available microbes and nutrients
4	Low	Medium	Medium	Low temperature probably mitigated by high boric acid concentration	
5	Low	Medium	Medium	not much reported for MIC in these systems; seems unlikely here	MIC can preferentially attack delta ferrite in austenitic weld metal
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	High	Medium	No food source and B inhibits MIC	

Subgroup **23.4**

Austenitic to austenitic weld metals
Type 308, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
1,2,3,4,6,9,10,12,13,15,16,17,19,20,21,23,25,26,28,30,32,34,36,39,40,41,43,44,48,49,50,51,52,53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	Not likely for high delta ferrite welds at these low temps and low effective potential	
5	Low	High	High	unlikely; needs high stresses and corrosive environment	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Medium	High	High	Limited concern at <100F	

Subgroup **23.5**

Forged austenitic stainless steel parts
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
5,7,11,14,18,22,27,29,33,35,37,38,42,45,46

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
2	Medium	Medium	Medium	Lab data limited. Good field experience.	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies.	
5	Low	High	High	Likely only in components subject to cyclic stress	Cyclic stresses applied to highly stressed components
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only expected to be a problem where flow induced vibration occurs during use, which is unlikely in a normally stagnant system
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Assume limited cyclic loading	

Subgroup **23.5**

Forged austenitic stainless steel parts
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
5,7,11,14,18,22,27,29,33,35,37,38,42,45,46

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
2	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
3	Low	Medium	Medium	MIC possible owing to the temperature and dilute boric acid and possible availability of nutrients	Available microbes and nutrients
4	Low	Medium	Medium	Low temperature probably mitigated by high boric acid concentration	
5	Low	Medium	Medium	not much reported for MIC in these systems; seems unlikely here	MIC possible in low T borated systems, but requires deposits/bacteria, nutrients, etc. to be present
6	Low	Medium	Medium	Low temperature normally stagnant lines. High boric acid concentration may mitigate	Availability of nutrients for the bugs
7	Low	Medium	Medium	Low temperature normally stagnant lines probably mitigated by high boric acid concentration	Availability of sulfate and nutrients
8	Low	High	Medium	No food source and B inhibits MIC	

Subgroup **23.5**

Forged austenitic stainless steel parts
Types 304, 316, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
5,7,11,14,18,22,27,29,33,35,37,38,42,45,46

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	Abused surfaces, high cold work, high residual stresses
4	0	High	High	Hard to see where the stress, material and environment components are coming from.	
5	Low	High	High	unlikely; needs high stresses and corrosive environment	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
8	Low	High	High	Limited concern at <100F	

Group **23** **Emergency Core Cooling Systems** **Safety Injection Pump Discharge Piping**

Subgroup **23.6**

Socket welds
Type 304, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
7,39

Notes: <1 inch instrumentation piping and access plugs

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	Depends on design detail and flow induced vibration
4	Medium	High	Medium	Significant field experience of failures	
5	Low	High	High	socket welds known to be susceptible to corrosion fatigue if high cyclic stresses applied	Cyclic stresses applied to highly stressed components
6	Medium	Medium	Medium	Socket welds have failed at multiple plants	Depends on flow induced vibration which seems unlikely in normally stagnant lines.
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures. Not sure if it's lower incidence than at higher temps.	Depends on design detail and flow induced vibration

Subgroup **23.6**

Socket welds
Type 304, Borated demin water
100°F, 1500-1700 psia

Applies to BNL Part #s with prefix ECCS-SIPMPD
7,39

Notes: <1 inch instrumentation piping and access plugs

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
2	0	High	Medium	Not likely at these low temperatures	
3	Low	Medium	Medium	In lower end of range for SCC. Accelerated by abused surfaces, cold work, sharp corners.	
4	Low	High	High	Possible under critical O2/T combination (cf BWR start-up experience). Not likely to be a generic problem	
5	Low	High	High	possible if high stresses or cold work present	
6	Low	High	High	Generally good field experience - believe some cracking has occurred due to chloride/sulfate contamination	Not anticipated to be a significant general problem due to low likelihood of chemical contamination
7	Low	High	High	Theoretical concern. Possibly synergy with high R fatigue.	
8	Medium	High	High	Includes HAZ, so SCC is a concern -- but corrosion fatigue will probably dominate	

Subgroup **24.1**

All carbon and low-alloy steel components
External surfaces (normally dry)
Containment/Turbine buidling air
445-530°F, 1035-1235 psia (inside condition)

Applies to BNL Part #s with prefix PCS-MS
1-89
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component, which is very unlikely for this component.	Requires a leak that is sufficient to keep the outer surface wet. No realistic possibility of this for the main steam system.
2	Low	Medium	Medium	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet. (Is there any realistic possibility of this for the main steam system?)
3	Low	Medium	Medium	BAC needs water, microbes, nutrients. Such conditions may occur under deposits or in sequestered regions	Microbes, nutrients, water
4	Medium	High	High	Well-known phenomenon if wet. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet.
5	Low	High	High	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet. Unlikely in this system
6	Low	Medium	High	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet. I think the main steam system is usually located such that this is extremely unlikely but I don't know the piping layouts for all plants
7	Low	High	High	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet. (Is there any realistic possibility of this for the main steam system?)
8	Medium	Medium	Medium	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet. (Is there any realistic possibility of this for the main steam system?)

Subgroup **24.1**

All carbon and low-alloy steel components
External surfaces (normally dry)
Containment/Turbine buidling air
445-530°F, 1035-1235 psia (inside condition)

Applies to BNL Part #s with prefix PCS-MS
1-89
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
2	Low	High	High	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
3	Low	Medium	Medium	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
4	Medium	High	High	Well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
6	Low	High	High	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Cl from insulation and aerosols, the latter increasing with time. Temperature can be high enough to minimize this problem	Concern only if wet. Insulation material is critical
8	Low	High	Medium	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time. Cl pitting of carbon steel usually occurs only at high pH.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.

Subgroup **24.1**

All carbon and low-alloy steel components
External surfaces (normally dry)
Containment/Turbine buidling air
445-530°F, 1035-1235 psia (inside condition)

Applies to BNL Part #s with prefix PCS-MS
1-89
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms	
2	Low	High	High	Probably not an issue	
3	Low	Medium	Medium	Well-known phenomenon. Requires a boric acid leak that falls onto the carbon steel or low-alloy steel component.	Requires a leak that is sufficient to keep the outer surface wet. (Is there any realistic possibility of this for the main steam system?)
4	Low	High	High	Unlikely degradation mode on external pipe surface even if wet unless particular combination of stress mode and concentration of OH, MoO4, etc.	This particular degradation mode not noted on external surface of PWR main steam lines.
5	Low	High	High	Known to occur in high T boilers	High stress, cold work required
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Cl from insulation and aerosols, the latter increasing with time. Temperature can be high enough to minimize this problem	Concern only if wet. Insulation material is critical
8	0	High	High	External dry surface	

Subgroup **24.2**

All carbon steel components and weldments
Saturated steam (<0.25% moisture)
445-530°F, 1035-1235 psia

Applies to BNL Part #s with prefix PCS-MS
All except for #1

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field failure experience has generally been good with a few notable exceptions with fatalities. Susceptible locations not that easy to identify.	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam.
2	Medium	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field failure experience has generally been good	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam.
3	Medium	High	High	FAC is likely in these system and has occurred often but after protracted times. Checworks or similar approach should be used to predict. Thickness monitors necessary. Accelerated by lowered pH, low oxygen. Reduced by adjust pH, increase oxidizing, ad	pH should be controlled to optimum. More oxidizing conditions desirable. Using higher Cr steel may lead to SCC.
4	High	High	High	Well-known phenomenon (e.g. tiger striping). Pipe wall-thickness measurements indicate that some wall-thinning can occur especially at elbows	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam well below 0.25% may stop problem but precise mitigation uncertain.
5	Medium	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field failure experience has generally been good	Trace element (e.g., chromium) content of carbon steel component. Low moisture content (<0.1%) of steam mitigates.
6	Medium	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field experience has generally been good	Trace element (e.g., chromium) content of carbon steel component and local moisture content of steam are key variables
7	High	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field failure experience has generally been good	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam.
8	Medium	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field failure experience has generally been good. Better education needed.	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam.

Subgroup **24.2**

All carbon steel components and weldments
Saturated steam (<0.25% moisture)
445-530°F, 1035-1235 psia

Applies to BNL Part #s with prefix PCS-MS
All except for #1

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Good field experience so far but a few failures attributed to fatigue have occurred. Flow induced vibration always a potential problem. Affected parts: 6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines. Also excessive vibration has occurred in main steam line following SG replacement
2	Low	Medium	Medium	Good field experience so far but a few failures attributed to fatigue have occurred. Affected parts: 6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.
3	Low	Medium	Medium	Good field experience so far but a few failures attributed to fatigue have occurred. Affected parts: 6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.
4	Medium	Medium	Medium	Good field experience so far but a few failures attributed to fatigue have occurred. Affected parts:6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.
5	Low	High	High	Good field experience so far but a few failures attributed to fatigue have occurred. Affected parts: 6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.
6	Low	Medium	Medium	Good field experience so far but a few failures attributed to fatigue have occurred. Affected parts:6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.
7	Low	High	High	Good field experience so far but a few failures attributed to fatigue have occurred. Affected parts: 6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.
8	Low	High	High	Good field experience so far but a few failures attributed to fatigue have occurred. Likelihood of large (surprising) environmental component is not large. Affected parts:6,7,14,15,16-19,26-36,42-46,49-53,56-60,63-67,70-74,77-89	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines.

Subgroup **24.2**

All carbon steel components and weldments
Saturated steam (<0.25% moisture)
445-530°F, 1035-1235 psia

Applies to BNL Part #s with prefix PCS-MS
All except for #1

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known realistic SCC mechanisms in saturated deoxygenated steam.	Presence/absence of oxygen
2	Low	Medium	Medium	Probably only an issue at high stresses. Very good field experience	
3	Low	Medium	Medium	Carbon steel sustains SCC at these temperatures but usually at higher oxygen. However, presence of pits may initiate SCC even in absence of oxygen.	Conditions for SCC should be investigated.
4	Medium	High	High	Possible degradation mode which may dominate over FAC for specific combinations of stress and environment. The precise turn-over condition between the two modes is unknown	
5	Low	High	Medium	not aware of plant failures assigned to this mechanism	Requires high stresses and oxidizing environment.
6	Low	High	High	Not likely to occur, in my opinion	
7	Low	High	High	Potential problem. In general, low moisture steam may not cause SCC but SCC by steam oxidation is a potential degradation mechanism.	Steam oxidation
8	Low	High	High	Likelihood of initiation and growth under low potential conditions is not high unless stresses are very high.	

Subgroup
24.3

Low alloy steel components
Saturated steam (<0.25% moisture)
445-530°F, 1035-1235 psia

Applies to BNL Part #s with prefix PCS-MS
1
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	High	Well-known phenomenon. Low alloy steels very much less susceptible than carbon steels.	Local moisture content of steam.
2	Low	High	High	Unlikely if steam wetness remains within specifications	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam.
3	Medium	High	High	FAC is likely in these system and has occurred often but after protracted times. Checworks or similar approach should be used to predict. Thickness monitors necessary. Accelerated by lowered pH, low oxygen. Reduced by adjust pH, increase oxidizing, ad	pH should be controlled to optimum. More oxidizing conditions desirable. Using higher Cr steel may lead to SCC.
4	Low	High	High	Cr alloying will decrease susceptibility	
5	Low	High	High	Unlikely to occur in these systems (dry steam)	Can occur if jetting, high local flows/turbulence are generated by geometric factors (I.e. valve outlets)
6	Low	High	High	A known vulnerability for LAS but not likely to occur to a significant extent under these conditions.	Field experience has been good. Moisture content of steam is a key variable.
7	High	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some wall-thinning can occur but field failure experience has generally been good	Trace element (e.g., chromium) content of carbon steel component. Local moisture content of steam.
8	Low	High	High	Two phase flow can affect carbon and low alloy steels alike. Some plants may run at or above the 0.25% moisture level. High velocities and bends could cause problems.	

Subgroup **24.3**

Low alloy steel components
Saturated steam (<0.25% moisture)
445-530°F, 1035-1235 psia

Applies to BNL Part #s with prefix PCS-MS
1

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known SCC mechanisms in deoxygenated saturated steam.	Presence/absence of oxygen
2	Low	Medium	Medium	Probably only an issue at high stresses. Very good field experience	
3	Low	Medium	Medium	Carbon steel sustains SCC at these temperatures but usually at higher oxygen. However, presence of pits may initiate SCC even in absence of oxygen.	Conditions for SCC should be investigated.
4	Low	Medium	Medium	Alloying (especially Cr) or heat treatments that increase yield stress will increase susceptibility (cf higher-alloyed turbine wheel steels). Not likely to be a problem with SA508 SG nozzles under normal fabrication conditions	Effect of contaminants in steam a concern that is inadequately understood. Of particular concern would be Cl (cf PSI work in water).
5	Low	High	High	Unlikely to occur in dry steam	significant moisture and high stress
6	Low	High	High	Not likely to occur, in my opinion	
7	Low	High	High	Potential problem. In general, low moisture steam may not cause SCC but SCC by steam oxidation is a potential degradation mechanism.	Steam oxidation
8	Low	High	High	Likelihood of initiation and growth under low potential conditions is not high unless stresses are very high.	

Subgroup **25.1**

All carbon steel components/welds/HAZ
External surfaces
Containment or valve room, Some plants outdoor
400°F max (external surface), 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-MFW
1-56
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	--	--	--	Treated in sub-group 25.4	
2	Low	High	High	well-known phenomenon; requires cyclic stress	
3	Low	Medium	Medium	Not sure of the vibrational frequency. corrosion fatigue may contribute to ripple for accelerating SCC.	low frequency ripple
4	Low	High	High	well-known phenomenon; requires cyclic stress	requires corrosive impurity buildup, moisture and high low cycle stresses
5	Low	High	High	well-known phenomenon; requires cyclic stress	requires corrosive impurity buildup, moisture and high low cycle stresses
6	Low	High	High	well-known phenomenon; requires cyclic stress (which is most likely at small-diameter branch connections	requires corrosive impurity buildup, moisture and high cycle stresses
7	Low	High	High	Cl from insulation and aerosols, the latter increasing with time. Temperature can be high enough to minimize this problem	requires corrosive impurity buildup, moisture and high low cycle stresses
8	Low	High	High	Phenomenon understood; requires cyclic stress	Requires corrosive impurity buildup, moisture and high low cycle stresses

Subgroup **25.1**

All carbon steel components/welds/HAZ
External surfaces
Containment or valve room, Some plants outdoor
400°F max (external surface), 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-MFW
1-56
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well-known phenomenon; requires deposits and/or insulation impurities; buildup with time.	Chlorides, sulphides, copper, etc. impurities required, plus moisture.
2	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	Low	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time. Should not occur in these rooms	chlorides, sulphides, copper, etc. impurities required, plus moisture.
6	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Cl from insulation and aerosols, the latter increasing with time. Temperature can be high enough to minimize this problem	Concern only if wet. Insulation material is critical
8	Low	High	High	Phenomenon understood; requires deposits and/or insulation impurities; buildup with time	Chlorides, sulphides, copper, etc. impurities required, plus moisture.

Subgroup **25.1**

All carbon steel components/welds/HAZ
External surfaces
Containment or valve room, Some plants outdoor
400°F max (external surface), 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-MFW
1-56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	Well characterized and only an issue under very specific loading conditions. Very good field experience	possible on outside piping if there is an insulation failure or after very long times with chloride buildup on repeated insulation removal under outages
3	Low	Medium	High	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen	Water or wetness. Contributions from sources of impurities
4	Low	High	High	Unlikely under nominally dry conditions	
5	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time. Should not occur in these rooms	chlorides, sulphides, copper, etc. impurities required, plus moisture.
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Cl from insulation and aerosols, the latter increasing with time. Temperature can be high enough to minimize this problem	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **25.2**

I-690 forging and associated weld/HAZ
External surfaces
Containment air
400°F max (external surface), 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-MFW
2
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fully austenitic - fracture resistance not an issue	
2	0	High	Medium	not an issue	
3	Medium	Medium	Medium	Possible loss of fracture toughness of 690 welds due to Mills effect.	
4	Low	High	Medium	Embrittlement due to LTCP unlikely due to lack of H buildup on external surface and to very low temperature. However residual concern that fracture toughness in environment may be decreased	
5	--	Low	Low		
6	0	High	High	I don't think the conditions required for LTCP are likely to be met at the external surface of an Alloy 690 component in the feedwater system	
7	0	High	High	FR can be lower after low temperature aging (LTA) only in environments	Some kind of GB microstructure may cause SCC under some certain condition in 690 HAZ
8	Low	High	Medium	Some concern for in-situ FR, but not from external environment / H2.	

Subgroup **25.2**

I-690 forging and associated weld/HAZ
External surfaces
Containment air
400°F max (external surface), 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-MFW
2
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Alloy 690 very resistant to localized corrosion	Highly unlikely in containment atmosphere
2	0	High	Medium	not an issue at this temperature	highly unlikely in containment
3	Low	High	High	Unlikely pitting on 690 especially at low temperatures	highly unlikely in containment
4	0	High	High	Very unlikely for this highly alloyed Ni-base alloy at this low temp even if wet ; requires deposits and/or insulation impurities and buildup with time	highly unlikely in containment environment
5	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time	highly unlikely in containment
6	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time	highly unlikely in containment
7	0	High	High	Dry air. No pitting in 690 even ambient air with Cl	highly unlikely in containment
8	0	High	High	Phenomenon understood; requires deposits and/or insulation impurities; buildup with time. Pitting is very unlikely with alloy 690.	Highly unlikely in containment

Subgroup **25.3**

I-690 forging and associated weld/HAZ
Demineralized pH 9-10 water
450°F, 1200 psia

Applies to BNL Part #s with prefix PCS-MFW
2

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Corrosion fatigue properties in secondary water not well characterized.	Cyclic loading
2	Low	Low	Low	know of no data	
3	Low	Medium	Medium	Unlikely	
4	Medium	Medium	Medium	Only if there is a source of cyclic stressing due to thermal stratification	
5	Low	High	High	well-known phenomenon; requires cyclic stress	requires corrosive impurity buildup, moisture and high low cycle stresses
6	Low	Medium	Medium	Field experience has been good	Only likely to be an issue if the CUF exceeds about 0.1
7	Medium	Medium	Medium	Need more data for HAZ	
8	Low	High	High	Not sure that cyclic stresses are that great - if present, it will obviously accelerate cracking.	

Subgroup **25.3**

I-690 forging and associated weld/HAZ
Demineralized pH 9-10 water
450°F, 1200 psia

Applies to BNL Part #s with prefix PCS-MFW
2

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fully austenitic - fracture resistance not an issue	
2	0	High	Medium	not an issue	
3	Low	Medium	Medium	Possible loss of fracture toughness of 690 welds due to Mills effect.	
4	0	High	Medium	Embrittlement due to LTCP unlikely due to lack of H source	
5	--	Low	Low		
6	0	High	High	Alloy 690 is susceptible to loss of fracture resistance due to hydrogen effects at temperatures below 150°C but retains sufficient tearing resistance to make this vulnerability of no practical significance	
7	Medium	Medium	Medium	FR can be lower at HAZ with hydrogen generated at I690/water interface.EAC-induced FR reduction would be possible.	Some kind of GB microstructure may cause SCC under some certain condition in 690 HAZ
8	Low	High	Low	Some concern for in-situ effects on FR.	

Subgroup **25.3**

I-690 forging and associated weld/HAZ
Demineralized pH 9-10 water
450°F, 1200 psia

Applies to BNL Part #s with prefix PCS-MFW
2

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in de-oxygenated AVT water.	
2	Low	Medium	Medium	insufficient knowledge of material behavior in the long term, but good field experience to date	Very dependent on welding procedures, could be complex welding configuration
3	Low	Medium	Medium	SCC not likely at these temperatures in 690	Cold work, surface abuse
4	Low	High	Medium	Unlikely unless weld sensitized, lower knowledge score to signal concern about specific mechanical constraint effects in HAZ	
5	Low	High	High	well-known phenomenon; unlikely unless weld sensitized	weld metal/HAZ must be sensitized
6	Low	High	Medium	well-known phenomenon; unlikely unless weld sensitized. Field experience has been good	Most likely immediately adjacent to welds
7	Medium	Medium	Medium	Unlikely unless weld sensitized. Need more data for HAZ in relation to FR	Some kind of GB microstructure may cause SCC under some certain condition in 690 HAZ
8	Low	High	Medium	HAZ effects not fully understood in 690, esp. over a range of microstructures. Concern is lower than alloy 600, but is a concern because of assumption that 690 is immune to problems.	

Subgroup **25.4**

All carbon steel components/welds/HAZ
Demineralized pH 9-10 water
450°F, 1200 psia

Applies to BNL Part #s with prefix PCS-MFW
1-56

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Well-known phenomenon in CS systems. Well known cases in the nuclear industry with associated fatalities	High turbulent flow and low dissolved O2 required
2	High	High	High	well-known phenomenon in CS systems; these higher pH values can be mitigating unless oxygen too low	high turbulent flow and low dissolved O2 required
3	Medium	Medium	Medium	FAC is established effect. Failures have occurred. Failures can be mitigated by adjusting pH, potential, and alloy composition.	Combinations of pH, flow, potential. Lack of monitoring a problem as in Mihama 3.
4	High	High	High	well-known phenomenon in CS systems; well characterized and predicted by Checkworks	high turbulent flow and low dissolved O2 required
5	Medium	High	High	well-known phenomenon in CS systems;	high turbulent flow and low dissolved O2 required
6	High	High	High	well-known phenomenon in CS systems; has caused field failures	high turbulent flow and low dissolved O2 required
7	High	High	High	well-known phenomenon in CS systems;	high turbulent flow and low dissolved O2 required
8	Medium	High	High	Phenomenon understood in CS systems.	High turbulent flow and low dissolved O2 required

Subgroup **25.4**

All carbon steel components/welds/HAZ
Demineralized pH 9-10 water
450°F, 1200 psia

Applies to BNL Part #s with prefix PCS-MFW
1-56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Well-known in CS systems. Difficult to distinguish from SCC unless due to high frequency vibration.	High stress areas susceptible (flanges, welds, thermal stratification especially during hot standby); exacerbated by presence of corrosive impurities/oxygen
2	High	High	High	thermal fatigue has been reported frequently, but could have a corrosion contribution	high residual stress/welds, bends, etc.; vibration
3	Medium	Medium	Medium	Corrosion fatigue may provide ripple to accelerate SCC.	high residual stress/welds, bends, etc.; vibration
4	Medium	Medium	Medium	well-known in CS systems if there is a source of cyclic loading	high residual stress/welds, bends, etc.; vibration
5	Low	High	High	well-known in CS systems; requires cyclic stress	cyclic stress and high residual stress/welds, bends, etc.; vibration
6	Medium	High	High	well-known in CS systems. Regions where mixing of flow streams at different temperatures causes large, fluctuating thermal stresses have been particularly susceptible	high residual stress/welds, bends, etc.; vibration. Surface condition may also be an important factor
7	Medium	Medium	Medium	well-known in CS systems	high residual stress/welds, bends, etc.; vibration
8	Medium	Medium	High	Well-known in CS systems - if cyclic stresses are high enough, problems will occur	High residual stress/welds, bends, etc.; vibration

Subgroup **25.4**

All carbon steel components/welds/HAZ
Demineralized pH 9-10 water
450°F, 1200 psia

Applies to BNL Part #s with prefix PCS-MFW
1-56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated AVT water but possible during oxygenor oxidized copper transients. Difficult to distinguish from low frequency corrosion fatigue.	High stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
2	Low	High	High	well-known for CS but unlikely at MFW conditions	high residual stress/welds, bends, etc.
3	Medium	Medium	Medium	SCC can occur in carbon steels if initiated by a pit that may have formed during oxidizing conditions.	Pitting at shutdown.
4	Medium	High	High	well-known for CS under fairly concentrated chemical impurity conditions and/or dynamic loading conditions. However potential cracking susceptibility may be at maximum circa 400F, based on LAS experience in reasonable purity water,	high residual stress/welds, bends, etc.
5	Low	High	High	well-known for CS but unlikely at MFW conditions	high residual stress/welds, bends, etc.
6	Low	Medium	Medium	well-known for CS but unlikely at MFW conditions	high residual stress/welds, bends, etc.
7	Medium	Medium	Medium	well-known for CS but unlikely at MFW conditions	high residual stress/welds, bends, etc.
8	Low	High	High	Well-known for CS but unlikely under low potential conditions.	High residual stress/welds, bends, etc.

Subgroup **26.1**

All carbon steel components/welds/HAZ
External surfaces
Auxiliary building air
100°F max, 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-AFW
1-45
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Same as for pitting; corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	Well-known phenomenon. Dependent on surface condition	contaminants not limited to chlorides
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	
4	Low	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	flanges, gaskets, tight clearance areas at risk; occasionally seen in plants	creviced areas must be wet some of the time
6	Low	Medium	Medium	Won't occur in my opinion	
7	Low	High	High	Wet/dry may produce a condition for crevice.	Wet/dry repeat.
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **26.1**

All carbon steel components/welds/HAZ
External surfaces
Auxiliary building air
100°F max, 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-AFW
1-45
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	well-known phenomenon requires deposits and/or insulations impurities; buildup with time	
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	Medium	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time; wet-dry cycling aggressive
6	Low	High	High	well-known phenomenon; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Corrosive impurities from buildup of deposits	deposits must be wet some of the time

Subgroup **26.1**

All carbon steel components/welds/HAZ
External surfaces
Auxiliary building air
100°F max, 1200psia (inside condition)

Applies to BNL Part #s with prefix PCS-AFW
1-45
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen	Water or wetness. Contributions from sources of impurities
4	Low	High	High	SCC unlikely at this low temp and nominally dry conditions	
5	Low	High	High	corrosive impurities from buildup of deposits; can initiate at pits	deposits must be wet some of the time; wet-dry cycling aggressive
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **26.2**

All carbon steel components/welds/HAZ
Condensate Water
100°F, 1200 psia

Applies to BNL Part #s with prefix PCS-AFW
1-45

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion can occur if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Crevices and areas where deposits may accumulate
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	
4	Low	High	High		
5	Low	High	High	flanges, gaskets, tight clearance areas at risk; occasionally seen in plants	tight mechanical metal-metal or metal-non-metal joints
6	Low	High	High	Won't occur, in my opinion	
7	Low	High	High	Wet/dry may produce a condition for crevice.	Wet/dry repeat.
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **26.2**

All carbon steel components/welds/HAZ
Condensate Water
100°F, 1200 psia

Applies to BNL Part #s with prefix PCS-AFW
1-45

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Flow induced vibration always a potential risk	Cyclic loading
2	Medium	High	High	well-known phenomenon; requires cyclic stress	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
5	Medium	High	High	well-known to occur in CS piping systems if components subject to vibration	cyclic stress applied to high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
6	Medium	High	High	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
7	Low	Medium	Medium	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
8	Low	High	High	Known to occur in CS piping systems - obviously depends on amplitude/frequency of cyclic stress	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen

Subgroup **26.2**

All carbon steel components/welds/HAZ
Condensate Water
100°F, 1200 psia

Applies to BNL Part #s with prefix PCS-AFW
1-45

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Medium	High	High		
5	Low	High	High	MIC occurs in stagnant/low flow areas that are periodically flushed	stagnant lines, fouled systems, flushed periodically to recharge nutrients/bacteria
6	Medium	Medium	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present, but usual environment is NOT service water (emergency only)	stagnant lines, areas where deposits may accumulate
7	Low	Medium	Medium	Temperature is high enough to diminish MIC	Availability of sulfate and nutrients
8	Medium	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **26.2**

All carbon steel components/welds/HAZ
Condensate Water
100°F, 1200 psia

Applies to BNL Part #s with prefix PCS-AFW
1-45

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Low	Medium	Medium	Conditions for pitting most likely during shutdown.	Occur especially with oxygen
4	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
6	Low	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present, but usual environment is NOT service water (emergency only)	stagnant lines, areas where deposits may accumulate
7	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
8	Low	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate

Subgroup **26.2**

All carbon steel components/welds/HAZ
Condensate Water
100°F, 1200 psia

Applies to BNL Part #s with prefix PCS-AFW
1-45

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very unlikely in deoxygenated AVT water at low temperature without prolonged presence of unauthorized chemicals	
2	Low	High	High	unlikely at this temperature	
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits.
4	0	High	High	very unlikely at this temperature unless there was a remarkable amount of impurities	
5	Low	High	High	Can initiate at pits; high stress areas	Pits, flaws, other high stress areas at risk; welds that penetrate from outside to inside
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required
7	Low	High	High	SCC may take place under some condition with dynamic loading.	Stress source is important.
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **27.1**

All carbon steel components/welds/HAZ
External surfaces
Containment/valve room air
400°F max (external surface), 1200 psia (inside condition)

Applies to BNL Part #s with prefix PCS-SGBD
1-55
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Too hot for MIC	
2	0	High	Medium	not likely on external surfaces at such high temperatures	
3	Low	Medium	Medium	MIC is possible at these temperatures and the microbes must produce corrosive species.	Microbes, nutrients, water, oxygen
4	0	High	High	Hard to see how conditions for MIC could be created in this system	
5	Low	High	High	buildup of deposits and moisture/unlikely for SGBD system	needs moist environment in an under-deposit situation
6	0	High	High	MIC isn't likely in my opinion because there are periods when the surface will be at high temperature	
7	0	High	High	Temperature is high enough to diminish MIC	
8	0	High	High	Can't occur at 400F	

Subgroup **27.1**

All carbon steel components/welds/HAZ
External surfaces
Containment/valve room air
400°F max (external surface), 1200 psia (inside condition)

Applies to BNL Part #s with prefix PCS-SGBD
1-55
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from insulation or buildup of deposits	Insulation or deposits must be wet some of the time
2	Low	High	High	corrosive impurities from insulation or buildup of deposits/unlikely for SGBD system	insulation or deposits must be wet some of the time
3	Low	Medium	Medium	Water drips, impurities available from insulation, external sources.	Wetness, impurities
4	Low	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	corrosive impurities from insulation or buildup of deposits/unlikely for SGBD system	insulation or deposits must be wet some of the time; not expected in these buildings
6	Low	High	High	corrosive impurities from insulation or buildup of deposits, but T = 400F	insulation or deposits must be wet some of the time
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Corrosive impurities from insulation or buildup of deposits/unlikely for SGBD system	Insulation or deposits must be wet some of the time

Subgroup **27.1**

All carbon steel components/welds/HAZ
External surfaces
Containment/valve room air
400°F max (external surface), 1200 psia (inside condition)

Applies to BNL Part #s with prefix PCS-SGBD
1-55
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	Will depend on contaminants and deposits, not only chlorides	
3	Low	Medium	Medium	SCC can occur at these temperatures when wet and oxidizing.	Wetness, impurities
4	Low	High	High	Possible if wet and if silicates present due to leaching from insulation but unlikely at this low temp and nominally dry condition	
5	Low	High	High	corrosive impurities from insulation or buildup of deposits/unlikely for SGBD system	insulation or deposits must be wet some of the time; not expected in these buildings
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **27.2**

All carbon steel components/welds/HAZ
Saturated water from Steam Generator
550°F, 1200 psia

Applies to BNL Part #s with prefix PCS-SGBD
1-55

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Well-known to occur in CS piping systems (temperatures > 200F) especially in blowdown lines	High flows and turbulence contribute to FAC, for example parts 22 to 28 and 30 to 55
2	High	High	High	well-known to occur in CS piping systems; temperatures > 200F	high flows, turbulence and cavitation (valves) contribute to FAC
3	Medium	Medium	Medium	FAC at high blowdown velocities.	pH, potential and flow in right combination
4	High	High	High	well-known to occur in CS piping systems at temperatures > 200F and especially in 2 phase environments and if particulates present	high flows, turbulence and cavitation (valves) contribute to FAC
5	High	High	High	well-known to occur in CS blowdown piping systems	high flows, turbulence and cavitation (valves) contribute to FAC; geometry a factor (elbows)
6	Medium	High	High	well-known to occur in CS piping systems, particularly at temperatures > 200F	high flows, turbulence and cavitation (valves) contribute to FAC
7	Medium	Medium	Medium	well-known to occur in CS piping systems; temperatures > 200F	high flows, turbulence and cavitation (valves) contribute to FAC
8	Medium	High	High	Known to occur in CS piping systems - plus solids are present	High flows, turbulence and cavitation (valves) contribute to FAC

Subgroup **27.2**

All carbon steel components/welds/HAZ
Saturated water from Steam Generator
550°F, 1200 psia

Applies to BNL Part #s with prefix PCS-SGBD
1-55

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Well-known to occur in CS piping systems	High stress areas susceptible (flanges, welds, reducers, thermal stratification)
2	High	High	High	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, reducers, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
3	Low	Medium	Medium	Corrosion fatigue possible when periodic blowdown or high frequency during blowdown itself.	need information on cyclic type
4	Medium	High	High	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, reducers, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
5	Medium	High	High	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, reducers, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
6	Medium	High	High	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, reducers, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
7	Low	Medium	Medium	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
8	Medium	High	High	Known to occur in CS piping systems - obviously depends on conditions not listed in description field	High stress areas susceptible (flanges, welds, reducers, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen

Subgroup **27.2**

All carbon steel components/welds/HAZ
Saturated water from Steam Generator
550°F, 1200 psia

Applies to BNL Part #s with prefix PCS-SGBD
1-55

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Difficult to distinguish from SCC unless due to high cycle vibration	
2	Low	High	High	Well characterized and only an issue under very specific loading conditions. Very good field experience	
3	Low	Medium	Medium	SCC occurs in CS at these temperatures if some defect can develop that will initiate SCC under deaerated conditions.	Need information on possible initiation occurrences
4	Medium	High	Medium	SCC certainly possible ,e specially at higher temp range. Specific conditions will be associated with off chemistry conditions that might lead to high concentrations of e.g. nitrate, plus oxygenated water. Uncertainty as to whether such conditions could	
5	Low	High	High	possible, especially at welds/HAZ where stress high	welds most likely area at risk
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required
7	Low	High	High	SCC may take place under some condition with dynamic loading.	Stress source is important.
8	Low	High	High	Known to occur in CS piping systems - obviously depends on conditions not listed in description field	

Subgroup **27.3**

All carbon steel components/welds/HAZ
Wet Layup Line, Demin water
60-100°F, 100 psia

Applies to BNL Part #s with prefix PCS-SGBD
1-55

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Normally stagnant zones such as parts 1-18, 20 and 21; demineralized water environment of these lines should not be a problem unless polluted
2	Low	High	High	stagnant water under long periods	nutrients available from steam generator blowdown
3	Medium	Medium	Medium	MIC is especially aggressive when the temperature is in this range and when the water is stagnant. The absence of boric acid permits microbes to thrive so long as some nutrients are present.	Nutrients are required. Stagnant water favors
4	Medium	High	High	Possible if decontaminated demin. water	
5	Low	High	High	unlikely unless line stagnant and aerated at low temperature for some time (e.g. layup)	
7	Low	High	High	Only low temperature issue.	
8	Medium	High	High	If demin, MIC is not likely, but stagnant water may not be very high purity	

Subgroup **27.3**

All carbon steel components/welds/HAZ
Wet Layup Line, Demin water
60-100°F, 100 psia

Applies to BNL Part #s with prefix PCS-SGBD
1-55

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Normally stagnant zones such as parts 1-18, 20 and 21
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	
3	Medium	Medium	Medium	If the environment is stagnant and if oxygen is present in the range above 10 ppm, pitting can occur. The pitting will be accelerated in the presence of conductive ions	Oxygen is required. Deposits and crevices accelerate.
4	Low	High	High		
5	Medium	High	High	known to occur in carbon steel lines if not fully drained	stagnant water left in lines
7	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
8	Low	High	High		

Subgroup **27.3**

All carbon steel components/welds/HAZ
Wet Layup Line, Demin water
60-100°F, 100 psia

Applies to BNL Part #s with prefix PCS-SGBD
1-55

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very unlikely in deoxygenated water at low temperature without prolonged presence of unauthorized chemicals	
2	0	High	Medium	not an issue at these temperatures	
3	Medium	Medium	Medium	SCC of carbon steel can occur in in the range as low as at least 90F if oxygen is present even in pure water.	High stresses due to CW or other residual sources such as welds.
4	Low	High	High	Unlikely at these low temperatures	
5	Low	High	High	unlikely unless very highly stressed or coldworked	
7	Low	High	High	SCC may take place under some condition with dynamic loading.	Stress source is important.
8	Low	High	High	Not that likely at 60F	

Group **28** **Support System** **Service Water Suction Piping from Pond**

Subgroup **28.1**

All carbon steel components/welds/HAZ
External surfaces
Auxiliary building /valve room air
100°F max, 35 to 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
1 to 6, 30 to 49

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely unless buried or submerged	Presence of moisture, sulfate and nutrients; absence of oxygen
2	Low	High	High	probably not a concern for external surfaces in buildings if good practice applied	
3	Low	Medium	Medium	Temperature range is right for MIC and less control of external environments seems to occur. Need MIC microbes that produce corrosive metabolic products	Availability of microbes, water, oxygen
4	0	High	High	Hard to see how conditions for MIC could be created in this system	
5	Low	High	High	needs buildup of deposits and moisture	deposits must be wet some of the time
6	Low	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Low	High	High	Certainly can occur - but piping is not insulated and not likely to be wet	

Subgroup **28.1**

All carbon steel components/welds/HAZ
External surfaces
Auxiliary building /valve room air
100°F max, 35 to 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
1 to 6, 30 to 49

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	corrosive impurities from buildup of deposits, not a concern if good practice applied	deposits must be wet some of the time
3	Low	Medium	Medium	Wet, impurities	Wet and impurities
4	Low	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	corrosive impurities from buildup of deposits/unlikely in these buildings	deposits must be wet some of the time
6	Low	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - but piping is not insulated and not likely to be wet	deposits must be wet some of the time

Group **28** **Support System**

Service Water Suction Piping/Pond

App.E.4 - All PWR Scores

Subgroup **28.1**

All carbon steel components/welds/HAZ
External surfaces
Auxiliary building /valve room air
100°F max, 35 to 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
1 to 6, 30 to 49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue for carbon steels in buildings	
2	Low	Medium	Medium	Most likely near welds witth high stresses.	Impurities from external environmemnt aggressive.
4	Low	High	High	Unlkely at these low temperatures in the defined external environments, even if the insulation is wet. Only reason for not marking Susceptibility as 0 is the slight possibility of dynamic loading increasing the possibility of cracking	
5	Low	High	High	Very unlikely unless corrosive contaminants present (carbonates, for instance)	
6	0	High	High	Unlikely, based on both lab data and field experience	
7	Medium	High	High	Well characterized and mitighated	Surface contamination.
8	Low	High	High		

Subgroup **28.2**

All carbon steel components/welds/HAZ
External surface - Buried pipe with cathodic protection
Ambient temperature, 35 to 125 psia max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
7 to 29

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Unlikely for buried pipelines unless subject to unexpected loads from heavy vehicles	
2	Low	High	High	Occurs if people dive over on a regular basis.	
4	Medium	High	High	fatigue is possible if vibratory stresses due to inadequate support (unlikely for buried pipe), with environmnetal enhanceemnt due to mismanaged cathodic protection	
5	Low	High	High	Unlikley; needs high vibration levels	
7	Low	High	High	Various cyclic loading ispossible	Cyclic stress, number of cycle and amplitude
8	Low	High	High	Expect little fatigue in buried pipes	

Subgroup **28.2**

All carbon steel components/welds/HAZ
External surface - Buried pipe with cathodic protection
Ambient temperature, 35 to 125 psia max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
7 to 29

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Serious loss of wall thickness can be expected if coating and cathodic protection system not properly designed and maintained	Need to ensure cathodic protection effective; buried pipe needs routine inspection plan
2	Medium	High	High	a concern if cathodic protection fails, or at plants where salt is used to keep roads clear	these lines are not high priority even though knowledge and guidance exist
3	Low	Medium	Medium	GC common in carbon steels exposed to service water	
4	Medium	High	High	Possible if CP not working effectively (Scoring made on this basis)	
5	Low	High	High	general corrosion of CS occurs on bare pipe; disbonded areas	areas where bare pipe exposed
6	Medium	Medium	Medium	Most likely if the cathodic protection system is wrongly set or malfunctioning, but best practice guideline available	
7	Medium	High	High	Well known phenomenon when cathodic protection fails	
8	Medium	High	High		

Subgroup **28.2**

All carbon steel components/welds/HAZ
External surface - Buried pipe with cathodic protection
Ambient temperature, 35 to 125 psia max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
7 to 29

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC of buried CS piping a well-known degradation mechanism but mitigated by alkalinity if cathodic protection system is properly designed and operational.	Need to ensure cathodic protection effective; buried pipe needs routine inspection plan
2	Medium	High	High	all the necessary conditions present	
3	Low	Medium	Medium	MIC feeds on coatings	microbes, nutrients, water, oxygen
4	Medium	High	High	pitting and MIC of buried CS piping a well-known degradation mechanism if CP system fails	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
5	Medium	High	High	MIC of buried CS piping a well-known degradation mechanism	need to ensure cathodic protection effective; buried pipe needs routine inspection plan/corrosion occurs at flaws in coatings
6	Medium	Medium	Medium	pitting and MIC of buried CS piping a well-known degradation mechanism	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Medium	High	High	Cathodic protection system design and operation/maintenance can be flawed	

Subgroup **28.2**

All carbon steel components/welds/HAZ
External surface - Buried pipe with cathodic protection
Ambient temperature, 35 to 125 psia max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
7 to 29

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Pitting of buried CS piping a well-known degradation mechanism but effectively mitigated if cathodic protection system is properly designed and operational.	Need to ensure cathodic protection effective; buried pipe needs routine inspection plan
2	Medium	High	High	a well-known degradation mechanism	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
3	Low	Medium	Medium	Debonding may occur and focus corrosion or SCC.	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
4	Medium	High	High	pitting and MIC of buried CS piping a well-known degradation mechanism if CP system fails	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
5	Medium	High	High	pitting of buried CS piping a well-known degradation mechanism	need to ensure cathodic protection effective; buried pipe needs routine inspection plan/corrosion occurs at flaws in coatings
6	Medium	Medium	Medium	pitting and MIC of buried CS piping a well-known degradation mechanism	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
7	Low	Medium	Medium	Pitting and MIC of buried CS piping a well-known degradation mechanism. Stray current may cause additional local corrosion	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
8	Medium	High	High	Pitting and MIC of buried CS piping a well-known degradation mechanism. Cathodic protection system design and operation/maintenance can be flawed.	need to ensure cathodic protection effective; buried pipe needs routine inspection plan

Group **28** **Support System** **Service Water Suction Piping Pond**

Subgroup **28.2**

All carbon steel components/welds/HAZ
External surface - Buried pipe with cathodic protection
Ambient temperature, 35 to 125 psia max (inside condition)

Applies to BNL Part #s with prefix SS-SWSUC
7 to 29

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Carbonate/bicarbonate cracking a well known hazard for coated cathodically protected pipelines where coating disbonding occurs. Also in slightly acid ground waters and some cyclic loading.	Need to ensure cathodic protection effective; buried pipe needs routine inspection plan
2	Low	High	High	will depend on the precise environment and surface condition	
3	Medium	Medium	Medium	SCC possible at cathodic potentials.	residual stresses
4	Medium	High	High	SCC possible at debonded coatings (cf natural gas pipelines)	
5	Low	High	High	SCC can initiate at flaws in exposed pipe	SCC can initiate at pits in pipe; most likely at flaws in coating where pitting and MIC can occur
6	Medium	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Cathodic protection system design and operation/maintenance can be flawed	

Group **28** **Support System** **Service Water Suction Piping from Pond**

Subgroup **28.3**

All carbon steel components/welds/HAZ
Pond water (raw water)
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
1-49

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Can occur in CS piping systems but temperature to low to be a serious concern	FAC possible but unlikely in this system
2	Low	High	High	FAC possible but unlikely in this system	
3	Low	Medium	Medium	Flows uncertain but turbulence	Locations of turbulence
4	Low	High	High	well-known to occur in CS piping systems but at higher temps than nominal for this defined system; temperatures > 200F	
5	--	--	--	FAC unlikely in this system at design flows and temperatures	FAC theoretically possible but unlikely in this system
6	Low	Medium	Medium	well-known to occur in CS piping systems but temperature here only 100F	FAC possible but unlikely in this system
7	Medium	Medium	Medium	well-known to occur in CS piping systems; temperatures > 200F	high flows, turbulence and cavitation (valves) contribute to FAC
8	Low	High	High	Known to occur in CS piping systems; temperatures > 200F. Certainly can occur - depends on details of surface conditions not provided in description.	FAC possible but unlikely in this system

Subgroup **28.3**

All carbon steel components/welds/HAZ
Pond water (raw water)
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
1-49

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	Low temperature normally stagnant conditions	
3	High	High	Medium	Depends on availability of water, oxygen, right microbes	Microbes, water, oxygen, nutrients
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Low	High	High	MIC can occur in stagnant/low flow areas that are regularly flushed	stagnant lines, areas where deposits may accumulate
6	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Medium	High	High	Certainly can occur - depends on details of surface conditions not provided in description.	

Subgroup **28.3**

All carbon steel components/welds/HAZ
Pond water (raw water)
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
1-49

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	Stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water.
2	Medium	High	High	Occurs in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	High	High	Medium	Oxygen present, impurities.	Oxygen, water, impurities
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
6	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
7	Low	Medium	Medium	Pitting and MIC of buried CS piping a well-known degradation mechanism.	need to ensure cathodic protection effective; buried pipe needs routine inspection plan
8	Low	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate

Group **28** **Support System** **Service Water Suction Piping - Pond**

Subgroup **28.3**

All carbon steel components/welds/HAZ
Pond water (raw water)
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
1-49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Less likely in service water at low temperature than from the outer surface	
2	Low	High	High	will depend on the precise environment and surface condition	
3	Low	Medium	Medium	Can initiate from pits even at low temps	Pits, oxygen, water, impurities
4	Low	High	Medium	SCC certainly possible ,but unlikely at this low temperature. Specific conditions will be associated with off chemistry conditions that might lead to high concentrations of e.g. nitrate, plus oxygenated water. Uncertainty as to whether such conditions can exist	
5	Low	High	High	SCC can initiate at flaws such as pits, scratches, etc./ unlikely in this system	SCC can initiate at pits in pipe; most likely at flaws in coating where pitting and MIC can occur
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description.	

Group **28** **Support System** **Service Water Suction Piping from Pond**

Subgroup **28.4**

All carbon steel components/welds/HAZ
Salt water in coated/lined pipe
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
Other Plants
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Serious and rapid crevice corrosion can occur if coating fails	Internal coating integrity
2	Medium	High	High	if coating or liner fails, will probably be rapid and local	
3	High	High	Medium	Coatings and deposits accelerate corrosion if oxygen present	Coatings and deposits
4	High	High	High	Depends on nature of coating	
5	Medium	High	High	possible under deposits and in mechanical joints and where lining cracked or broken	
6	Medium	Medium	Medium	Will depend on integrity of coating	Coating must fail locally first
8	Medium	High	High	Problems with flaws in coating	

Subgroup **28.4**

All carbon steel components/welds/HAZ
Salt water in coated/lined pipe
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
Other Plants
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Significant risk under fouling	Presence of fouling deposits
2	Medium	Medium	Medium	Will depend on integrity of coating.	
3	Medium	Medium	Medium	This untreated water is good source for MIC and adequate nutrients present. Temperature range right	
4	High	High	High	Very possible degradation mechanism on inside of pipe, and outside of pipe if coating is defective	
5	Medium	High	High	macrofouling can lead to corrosion under deposits, especially at areas where coating is breached or damaged.	
6	Medium	Medium	Medium	Will depend on integrity of coating	Coating must fail locally first
7	Medium	High	High	Coating or lining failure is very likely and MIC may take place.	Coating or lining failure
8	Medium	High	High		

Group **28** **Support System**

Service Water Suction Piping from Pond

Subgroup **28.4**

All carbon steel components/welds/HAZ
Salt water in coated/lined pipe
100°F, 35 to 125 psia design

Applies to BNL Part #s with prefix SS-SWSUC
Other Plants
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Serious and rapid pitting can occur if internal coating fails	Internal coating integrity
2	High	High	High	if coating or liner fails, will probably be rapid and local	
3	High	High	Medium	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present. Pitting occurs under coating as does MIC	stagnant lines, areas where deposits may accumulate
4	High	High	High	Failure of coating is presumed and is key to scoring	
5	Medium	High	High	possible if line stagnant occasionally and concrete cracked/broken	plastic piping or liner preferred
6	Medium	Medium	Medium	Will depend on integrity of coating	Coating must fail locally first
8	Medium	High	High	Problems with flaws in coating	stagnant lines, areas where deposits may accumulate

Subgroup **29.1**

All carbon steel components/welds/HAZ
External surfaces, Auxiliary building air
Rubber insulated at some plants
100°F max, 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWDIS
1-70
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely unless buried or submerged	Presence of moisture, sulphate and nutrients; absence of oxygen
2	Medium	High	High	probably not a concern for external surfaces in buildings if good practice applied	rubber insulation substantially increases likelihood for MIC
3	Low	Medium	Medium	Temperature range is right for MIC and less control of external environments seems to occur. Need MIC microbes that produce corrosive metabolic products	Availability of microbes, water, oxygen, nutrients
4	0	High	High	Hard to see how conditions for MIC could be created in this system	
5	Low	High	High	buildup of deposits can be MIC initiation sites	deposits must be wet some of the time
6	Low	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Medium	High	High	Certainly can occur - but piping is rubber insulated in some plants and likely to be wet	

Subgroup **29.1**

All carbon steel components/welds/HAZ
External surfaces, Auxiliary building air
Rubber insulated at some plants
100°F max, 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWDIS
1-70
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Corrosive impurities from buildup of deposits and presence of condensation	Deposits must be wet some of the time
2	Medium	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time
3	Low	Medium	Medium	Wet, impurities	Wet and impurities
4	Low	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	corrosive impurities from buildup of deposits can be pit initiation sites	deposits must be wet some of the time
6	Low	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Medium	High	High	Certainly can occur - but piping is rubber insulated in some plants and likely to be wet	Deposits may be wet some of the time, and problems will then develop

Subgroup **29.1**

All carbon steel components/welds/HAZ
External surfaces, Auxiliary building air
Rubber insulated at some plants
100°F max, 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWDIS
1-70
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC seems unlikely if not buried or submerged but presence of condensation under rubber insulation a detrimental factor.	
2	Low	High	High	could occur in the rubber insulated piping with condensed water and corrosive impurities	
3	Low	Medium	Medium	SCC can occur at these temperatures especially in oxygenated water	
4	Low	High	High	Possible if silicates present due to leaching from insulation but unlikely at this low temp and nominally dry condition	
5	Low	High	High	SCC can initiate at flaws such as pits	deposits must be wet some of the time
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required, plus moisture.
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - but piping is rubber insulated in some plants and likely to be wet	

Subgroup **29.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
1-70

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well-known to occur in CS piping systems (usually temperatures > 200F) but also known in cold water lines	High flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC
2	Low	High	High	well-known to occur in CS piping systems; usually temperatures > 200F but also in cold water lines occasionally	high flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC
3	Medium	High	High	Well-known to occur in CS piping systems; usually temperatures > 200F but also in cold water lines occasionally	High flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC
4	Low	High	High	well-known to occur in CS piping systems but at higher temps than nominal for this defined system; temperatures > 200F	high flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC
5	Low	High	High	well-known to occur in CS piping systems; usually temperatures > 200F but also in cold water lines occasionally/ unlikely here	high flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC
6	Low	Medium	Medium	well-known to occur in CS piping systems; usually temperatures > 200F but also in cold water lines occasionally	high flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC
7	Medium	Medium	Medium	well-known to occur in CS piping systems; temperatures > 200F	high flows, turbulence and cavitation (valves) contribute to FAC
8	Low	High	High	Known to occur in CS piping systems; usually temperatures > 200F but also in cold water lines occasionally. Certainly can occur - depends on details of surface conditions not provided in description	high flows, turbulence and cavitation (valves, reducers, pump outlets) contribute to FAC

Subgroup **29.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
1-70

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well-known to occur in CS piping systems but unlikely here unless flow induced vibration occurs	Cyclic loading; exacerbated by presence of corrosive impurities/oxygen
2	Low	High	High	well-known to occur in CS piping systems; unlikely here	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
3	Low	Medium	Medium	Flow	High stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
4	Low	High	High	well-known to occur in CS piping systems; unlikely here	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
5	Low	High	High	well-known to occur in CS piping systems; unlikely here because of lack of cyclic stress	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
6	Low	Medium	Medium	well-known to occur in CS piping systems; unlikely here	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
7	Medium	Medium	Medium	well-known to occur in CS piping systems; unlikely here	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
8	Low	High	High	Known to occur in CS piping systems; unlikely here. Certainly can occur - depends on details of cyclic loading	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen

Subgroup **29.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
1-70

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
3	Medium	Medium	Medium	Depends on availability of water, oxygen, right microbes	Microbes, water, oxygen
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Medium	High	High	MIC can occur in stagnant lines if oxygen, bacteria and other MIC-related impurities (sulphates, organics) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
6	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Medium	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **29.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
1-70

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	Stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water.
2	Medium	High	High	can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
3	Medium	Medium	Medium	Oxygen present, impurities, follows MIC.	Oxygen, water, impurities, MIC
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
6	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
7	Low	Medium	Medium	pitting and MIC of buried CS piping a well-known degradation mechanism	need to ensure cathodic protection effective;
8	Low	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulfates, chlorides) present.	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water

Subgroup **29.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
1-70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Less likely in service water at low temperature than from the outer surface	
2	Low	High	High	will depend on the precise environment and surface condition	
3	Low	Medium	Medium	Can initiate from pits even at low temps	Pits, oxygen, water, impurities
4	Low	High	Medium	SCC certainly possible ,but unlikely at this low temperature. Specific conditions will be associated with off chemistry conditions that might lead to high concentrations of e.g. nitrate, plus oxygenated water. Uncertainty as to whether such conditions c	
5	Low	High	High	SCC can initiate at flaws such as pits	pits, mechanical flaws, high stress areas such as welds
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required
7	Low	High	High	Well known phenomenon. Cl from insulation	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur - depends on details of surface conditions not provided in description	

Subgroup **29.3**

CCW HX Copper Zinc tubes
internal CCW water and external pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69

Notes: Apply to Other Plants also

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Brasses are susceptible to FAC	High flows (>5fps), turbulence
2	High	High	High	CuZn alloys susceptible to FAC	high flows (>5fps), turbulence
3	Low	Medium	Medium	Copper alloys susceptible to FAC	high flows (>5fps), turbulence
4	High	High	High	copper alloys susceptible to FAC, much less with Cu-Ni than Cu-Zn (which are almost extinct); required flow rates for degradation are 26ft/s vs 6 ft/s respectively	high flows (>5fps), turbulence
5	Low	High	High	copper alloys susceptible to FAC; 90:10 Cu:Ni somewhat resistant	high flows (>5fps), turbulence are areas at risk; shell side issue
6	Medium	High	High	copper alloys susceptible to FAC	high flows (>5fps), turbulence
7	Low	High	High	copper alloys susceptible to FAC	high flows (>5fps), turbulence
8	Low	High	High	Copper alloys susceptible to FAC	high flows (>5fps), turbulence

Subgroup **29.3**

CCW HX Copper Zinc tubes
internal CCW water and external pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69

Notes: Apply to Other Plants also

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC less likely on copper alloys	Stagnant conditions, deposit buildup can favor MIC on pond water side
2	Low	High	High	MIC not a large problem for copper	stagnant flow, deposit buildup can cause MIC
3	Medium	Medium	Medium	Pond water good source of microbes	Acid producing microbes, nutrients, oxygen, water
4	Low	High	High		stagnant flow, deposit buildup can cause MIC/pitting of water side; copper deposits on water side can cause pitting.
5	Medium	High	High	buildup of deposits on water side can generate conditions for MIC.	stagnant flow, deposit buildup can cause MIC of shell side
6	Low	Medium	Medium	known susceptibility. Need acid-producing microbes	
7	Low	Medium	Medium	carbon steel shell; copper contamination from tubes, raw water known to cause MIC/pitting	stagnant flow, deposit buildup can cause MIC/pitting of water side; copper deposits on water side can cause pitting.
8	Medium	High	High	Certainly can occur - depends on specific Cu alloy used (Cu-Ni is better)	stagnant flow, deposit buildup can cause MIC/pitting of water side; copper deposits on water side can cause pitting.

Subgroup **29.3**

CCW HX Copper Zinc tubes
internal CCW water and external pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69

Notes: Apply to Other Plants also

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Raw water can cause pitting in brasses.	Stagnant flow, deposit buildup on water side can cause pitting.
2	Medium	High	High	chlorides and oxydizing conditions present	
3	Medium	Medium	Medium	Presence of Cl and oxidizing conditions	Cl dilute
4	High	High	High	highly researched area, with pitting susceptibility highly dependent on specific alloy (worse for Cu-Zn) and environment	
5	Medium	High	High	can occur under deposits	aerated water with deposits and corrosive impurities increase risk; less likely in deaerated water; shell side issue
6	Medium	Medium	Medium	need Cl and oxidizing conditions; brasses more susceptible than CuNi alloys	
7	Medium	High	High	Need more data for quantitative evaluation.	
8	Medium	High	High	Certainly can occur - depends on specific Cu alloy used (Cu-Ni is better)	

Subgroup **29.3**

CCW HX Copper Zinc tubes
internal CCW water and external pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69

Notes: Apply to Other Plants also

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Dezincification of brass.	
2	Medium	High	High	copper alloys susceptible to SCC	environment poorly defined and variable
3	Medium	Medium	Medium	Copper alloys sustain SCC in dilute amoniacal environments and in presence of oxidizing anions.	Presence of ammoniacal radicals
4	High	High	High	highly researched area, demonstrating susceptibility to SCC in a wide variety of environments can form due, e.g., to organic matter breakdown, ammonium cations, citrates nitrits,tartrates, phosphates, carbonates,etc. Greatest susceptibility for Cu-Zn	
5	Low	High	High	brasses susceptible to SCC, sometimes induced by dezincification; 90:10 not as likely in these environments	SCC can initiate at flaws such as scratches, pits, etc.; shell side issue
6	Medium	Medium	Medium	Copper alloys susceptible to SCC in the presence of oxidizing anions; brasses more susceptible than CuNi alloys	
7	Low	Medium	Medium	Need more data for quantitative evaluation.	
8	Medium	High	High	Certainly can occur - depends on specific Cu alloy used (Cu-Ni is better)	

Subgroup **29.4**

CCW HX Shell and Tubesheets and fittings
Carbon steel
Pond Water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion/galvanic corrosion common in carbon steels exposed to raw water; dependent on conductivity and water softness	Coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets; corrosion under deposits; threaded components
2	Medium	High	High	highly creviced construction	depends on specific environmental conditions wrt impurities and general water quality
3	Medium	Medium	Medium	Deposits, adjacent fittings, oxygen, flow	
4	Medium	High	High	Highly researched area; this corrosion mode will occur unless adequately managed via well known techniques	
5	Medium	High	High	tight crevices can result in crevice corrosion	occurs in tight crevices such as at flanges, tubesheet joints, gasketted components; exacerbated by dissimilar metals in contact
6	Medium	High	High		
7	Low	Medium	Medium	Depend upon geometry and water chemistry	
8	Medium	High	High		

Subgroup **29.4**

CCW HX Shell and Tubesheets and fittings
Carbon steel
Pond Water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Serious loss of wall thickness can be expected if corrosion protection system inadequate	Need to ensure effective corrosion protection system and routine inspection plan
2	Medium	High	High	depends on specific environmental conditions wrt impurities and general water quality	
3	Medium	Medium	Medium	General corrosion expected with impurities, oxygen, water	
4	Medium	High	High	Highly researched area; this corrosion mode will occur unless adequately managed via well known techniques	
5	Low	High	High	occurs in dry air at a slow rate; occurs in oxygenated water at a rate unlikely to affect shell life unless significant corrosive impurity present.	shell requires visual inspection on both sides to ensure no significant wall thinning occurring as a result of general corrosion
6	Medium	High	High		
7	Low	High	High	Well known phenomenon.	
8	Low	High	High		

Subgroup **29.4**

CCW HX Shell and Tubesheets and fittings
Carbon steel
Pond Water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant zones under deposits in absence of oxygen and presence of nutrients and sulphate	Areas where deposits may accumulate
2	Medium	High	High	raw water known to cause MIC	
3	Medium	Medium	Medium	Microbes, nutrients, water, oxygen should be abundant; these are conditions for MIC	Water, oxygen, nutrients, microbes
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Medium	High	High	deposits and impurities in raw water known to cause MIC	stagnant flow, deposit buildup can cause MIC
6	Medium	High	High	carbon steel shell; copper contamination from tubes, raw water known to cause MIC	stagnant flow, deposit buildup can cause MIC/pitting of water side; copper deposits on water side can cause pitting.
7	Low	High	High	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Medium	High	High		

Subgroup **29.4**

CCW HX Shell and Tubesheets and fittings
Carbon steel
Pond Water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	Areas where deposits may accumulate. Systems that are periodically flushed with aerated water.
2	Medium	High	High	could be stagnant areas	depends on specific environmental conditions wrt impurities and general water quality
3	Medium	Medium	Medium	Pitting in carbon steel associated with service water should be expected	Water, impurities, oxygen
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Medium	High	High	copper contamination from tubes, impurities in raw water known to cause pitting	stagnant flow, deposit buildup can cause pitting; copper deposits on water side can cause pitting.
6	Medium	High	High	carbon steel shell; copper contamination from tubes, raw water known to cause pitting	stagnant flow, deposit buildup can cause MIC/pitting of water side; copper deposits on water side can cause pitting.
7	Low	High	High	pitting and MIC of buried CS piping a well-known degradation mechanism.	need to ensure cathodic protection effective;
8	Low	High	High		

Subgroup **29.5**

CCW HX SS tubes
Stainless steel
internal CCW water and external pond or sea water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion under deposits	Stagnant conditions, deposit buildup can favor crevice corrosion on pond water side
2	Medium	High	High	under stagnant conditions	
3	Low	Medium	Medium	Possibly CREV where deposits occur but such deposits would be not likely owing to flow; deposits could be associated with water animals	Deposit from insoluble materials and from barnacle type animals
4	Medium	High	High		
5	Medium	High	High	possible in low flow areas or under deposits	
6	Medium	Medium	Medium	Known susceptibility in presence of aggressive anions. Particularly with design crevices	
8	Medium	High	High	Concern for deposits/silt, lower flow, uncertain water chemistry …	

Subgroup **29.5**

CCW HX SS tubes
Stainless steel
internal CCW water and external pond or sea water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC can occur in raw water	Stagnant conditions and deposit buildup can favor MIC on pond water side
2	Medium	High	High	under stagnant conditions	
3	Low	Low	Medium	MIC might produce some pitting but probably not extensive.	Nutrients. Likely present
4	Medium	High	High		
5	Medium	High	High	possible in low flow areas or under deposits	
6	Low	Medium	Medium	Not thought to be a big issue for SS	Key element for damage to occur is low flow conditions
8	Medium	High	High	Concern for deposits/silt, lower flow, uncertain water chemistry …	

Subgroup **29.5**

CCW HX SS tubes
Stainless steel
internal CCW water and external pond or sea water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting possible under deposits	Stagnant flow and deposit buildup on water side can cause pitting.
2	Medium	High	High	under stagnant conditions	
3	Low	Medium	Medium	Pitting might occur with high oxygen but not extensive	High oxygen, possible MIC
4	Medium	High	High		
5	Medium	High	High	possible in low flow areas or under deposits	
6	Medium	Medium	Medium	Known susceptibility in presence of aggressive anions	Key element for damage to occur is low flow conditions
8	Medium	High	High	Concern for deposits/silt, lower flow, uncertain water chemistry …	

Subgroup **29.5**

CCW HX SS tubes
Stainless steel
internal CCW water and external pond or sea water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
69
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC can't be excluded at 100°F	
2	Medium	High	High	under stagnant conditions	
3	Low	Medium	Medium	SCC is possible but low possibility.	High residual stresses
4	Medium	High	High		
5	Low	High	High	possible at highly stressed areas such as tubesheet joints	
6	Low	Medium	Medium	Possible susceptibility in presence of aggressive anions, but T is low	Key element for damage to occur is low flow conditions
8	Medium	High	High	Concern for deposits/silt, lower flow, uncertain water chemistry …	

Subgroup **29.6**

CCW HX Copper Nickel tubes
Copper Nickel
internal CCW water and external pond (or sea) water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes: Apply to Other Plants also

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Copper-nickel alloys not susceptible to FAC under these conditions	
2	Low	High	High	not as susceptible as copper sinc	high flows (>5fps), turbulence
3	Low	Medium	Medium	FAC would be low for this material	Very high velocities but not likely
4	Low	High	High	Ni alloying severely decreases FAC susceptibly	high flows (>5fps), turbulence
5	Low	High	High	Cu-Ni relatively resistant to FAC unless very high flows	
6	Medium	High	High	copper alloys susceptible to FAC	high flows (>5fps), turbulence
8	Low	High	High	Copper alloys susceptible to FAC	high flows (>5fps), turbulence

Subgroup **29.6**

CCW HX Copper Nickel tubes
Copper Nickel
internal CCW water and external pond (or sea) water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes: Apply to Other Plants also

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC not likely on copper-nickel alloys	Stagnant conditions, deposit buildup can favor MIC on pond water side
2	Low	High	High	MIC not a large problem for copper	stagnant flow, deposit buildup can cause MIC
3	Low	Medium	Medium	MIC is slow but possible if nutrients present.	Nutrients present
4	Low	High	High		
5	Medium	High	High	has been seen especially where deposits form	
6	Low	Medium	Medium	known susceptibility. Need acid-producing microbes	
8	Low	High	High	Certainly can occur - depends on specific Cu alloy used (Cu-Ni is better)	stagnant flow, deposit buildup can cause MIC/pitting of water side; copper deposits on water side can cause pitting.

Subgroup **29.6**

CCW HX Copper Nickel tubes
Copper Nickel
internal CCW water and external pond (or sea) water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes: Apply to Other Plants also

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Copper-nickel very resistant to pitting	Stagnant flow, deposit buildup on water side can cause pitting.
2	Low	High	High		environment poorly defined and variable
3	Low	Medium	Medium	Material is pitting resistant; but could occur related to MIC	Most related to MIC but not much
4	Low	High	High	Ni alloying severely decreases Pitting susceptibly	
5	Medium	High	High	has been seen especially where deposits form	
6	Low	Medium	Medium	need Cl and oxidizing conditions; brasses more susceptible than CuNi alloys	
8	Low	High	High	Certainly can occur - depends on specific Cu alloy used (Cu-Ni is better)	

Subgroup **29.6**

CCW HX Copper Nickel tubes
Copper Nickel
internal CCW water and external pond (or sea) water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWDIS
67,68,70

Notes: Apply to Other Plants also

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Copper-nickel alloys very resistant	
2	Low	High	High	copper alloys susceptible to SCC	environment poorly defined and variable
3	Low	Medium	Medium	SCC seldom if ever reported	High residual stresses but chemistry not likely
4	Low	High	High	Ni alloying severely decreases SCC susceptibly	
5	Low	High	High	Cu-Ni relatively resistant to cracking; unlikely here	
6	Low	Medium	Medium	Copper alloys susceptible to SCC in the presence of oxidizing anions but brasses more susceptible than CuNi alloys	
8	Low	High	High	Certainly can occur - depends on specific Cu alloy used (Cu-Ni is better)	

Subgroup **30.1**

All carbon steel components/welds/HAZ
External surfaces
Containment building air
100°F max, 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWCONT
1-56
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely unless buried or submerged	Presence of moisture, sulfate and nutrients; absence of oxygen
2	0	High	Medium	probably not a concern for external surfaces in containment building	
3	Low	Medium	Medium	Temperature range is right for MIC and less control of external environments seems to occur. Need MIC microbes that produce corrosive metabolic products	Availability of microbes, water, oxygen, nutrients
4	0	High	High	Hard to see how conditions for MIC could be created in this system	
5	Low	High	High	buildup of deposits with accompanying nutrients/bacteria can cause MIC	deposits must be wet some of the time
6	Low	High	High	MIC not likely in containment, in my opinion	deposits must be wet some of the time
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Low	High	High	Certainly can occur, but surfaces should stay pretty dry; also, aren't usually insulated	

Subgroup **30.1**

All carbon steel components/welds/HAZ
External surfaces
Containment building air
100°F max, 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWCONT
1-56
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	probably not a concern for external surfaces in containment building	deposits must be wet some of the time
3	Low	Medium	Medium	Pitting occurs with oxygen, impurities, flow	deposits must be wet some of the time
4	Low	High	High	well-known phenomenon if wet; requires deposits and/or insulation impurities; buildup with time	chlorides, sulphides, copper, etc. impurities required, plus moisture.
5	Low	High	High	corrosive impurities from buildup of deposits can cause pitting	deposits must be wet some of the time
6	Low	High	High	corrosive impurities from buildup of deposits	deposits must be wet some of the time
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur, but surfaces should stay pretty dry; also, aren't usually insulated	deposits must be wet some of the time

Subgroup **30.1**

All carbon steel components/welds/HAZ
External surfaces
Containment building air
100°F max, 125 psia design max (inside condition)

Applies to BNL Part #s with prefix SS-SWCONT
1-56
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	probably not a concern for external surfaces in containment building	
3	Low	Medium	Medium	SCC observed in these waters but low frequency and low rates	High residual stresses
4	Low	High	High	Possible if silicates present due to leaching from insulation but unlikely at this low temp and nominally dry condition	
5	Low	High	High	SCC can initiate at mechanical flaws, pits, etc.	high stress areas such as welds, HAZ are areas of risk
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required plus moisture
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Certainly can occur, but surfaces should stay pretty dry; also, aren't usually insulated	

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion/galvanic corrosion common in carbon steels exposed to raw water	Coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets; corrosion under deposits; threaded components
2	Medium	High	High	highly creviced construction with many different pipe bore dimensions and connections	depends on specific environmental conditions wrt impurities and general water quality
3	Medium	Medium	Medium	general corrosion/galvanic corrosion common in carbon steels exposed to raw water	coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets; corrosion under deposits; threaded components
4	Medium	High	High	highly researched area; this corrosion mode will occur unless adequately managed via well known techniques	coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets; corrosion under deposits; threaded components
5	Low	High	High	crevice corrosion/galvanic corrosion common in carbon steels exposed to raw water where crevices present	occurs in tight crevices such as at flanges, gasketted components; exacerbated by dissimilar metals in contact
6	Medium	High	High	general corrosion/galvanic corrosion common in carbon steels exposed to raw water, especially in crevice locations	coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets; corrosion under deposits; threaded components
7	Low	Medium	Medium	general corrosion/galvanic corrosion common in carbon steels exposed to raw water	coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets;corrosion under deposits; threaded components
8	Medium	High	High	Concern at flanges, also under deposits	coupling to SS or other noble metals (copper, brass), typically at flanges/gaskets; corrosion under deposits; threaded components

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Cavitation possible in pumps, valves etc.	Design
2	Low	High	High	cavitation possible in pumps	
3	0	Low	Low	Doubt that erosion cutting is important. FAC is.	no basis
4	Low	Medium	Medium	well-known to occur in CS piping systems but at higher temps than nominal for this defined system; Note scoring is on the basis of cavitation not FAC	high flows, turbulence and cavitation (valves, pump outlets, impellers) contribute to FAC
5	Low	High	High	known to occur in CS piping systems in components such as pipes, valves, etc..	high flows, turbulence and cavitation (valves, pump outlets, impellers) contribute to EC
8	Low	High	High	Aggravated by particulates, but flow assumed to be not too high.	high flows, turbulence and cavitation (valves, pump outlets, impellers) contribute to FAC

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Can occur in CS piping systems (usually temperatures > 200F) but also seen in cold water lines. Not likely under the conditions here.	High flows and turbulence
2	Low	High	High	FAC possible but unlikely in this system	
3	Low	Medium	Medium	High velocity, non optimum pH	
6	Low	Medium	Medium	well-known to occur in CS piping systems; usually temperatures > 200F but also seen in cold water lines	high flows, turbulence and cavitation (valves, pump outlets, impellers) contribute to FAC
7	Medium	Medium	Medium	well-known to occur in CS piping systems; temperatures > 200F	high flows, turbulence and cavitation (valves) contribute to FAC

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well-known to occur in CS piping systems but unlikely here unless flow induced vibration occurs	Cyclic loading; exacerbated by presence of corrosive impurities/oxygen
2	Low	High	High	well-known to occur in CS piping systems, will be more prominent in the smaller bore piping	high stress areas susceptible (flanges, welds)
3	Low	Medium	Medium	High velocity vibrations and probably not major fatigue.	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
4	Low	High	High	well-known to occur in CS piping systems; unlikely here	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
5	Low	High	High	well-known to occur in CS piping systems; unlikely here because of lack of cyclic stress	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
6	Low	Medium	Medium	well-known to occur in CS piping systems	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen
7	Medium	Medium	Medium	well-known to occur in CS piping systems; unlikely here	high stress areas susceptible (flanges, welds, thermal stratification flow regions); exacerbated by presence of corrosive impurities/oxygen
8	Low	High	High	Known to occur in CS piping systems - depends on cyclic loading	high stress areas susceptible (flanges, welds, thermal stratification flows); exacerbated by presence of corrosive impurities/oxygen

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	low temperature normally stagnant lines	depends on specific environmental conditions wrt impurities and general water quality
3	Medium	Medium	Medium	Depends on availability of water, oxygen, right microbes	Microbes, water, oxygen, nutrients
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Medium	High	High	MIC can occur in stagnant lines if oxygen, bacteria and other MIC-related impurities (sulphates, organics) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
6	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
7	Low	Medium	Medium	Low temperature normally stagnant lines	Availability of sulfate and nutrients
8	Medium	High	High	Seems reasonably likely in pond water, esp. so in lower flow or stagnant sections	

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	Stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water.
2	Low	High	High	can occur in stagnant lines if oxygen and other corrosive impurities present	
3	Medium	Medium	Medium	Oxygen present, impurities.	Oxygen, water, impurities
4	High	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
5	Medium	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate. Systems that are periodically flushed with aerated water
6	Medium	High	High	Pitting/MIC can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
7	Low	Medium	Medium	pitting and MIC of buried CS piping a well-known degradation mechanism	need to ensure cathodic protection effective;
8	Medium	High	High	Seems reasonably likely in pond water, esp. so in lower flow or stagnant sections	stagnant lines, areas where deposits may accumulate

Subgroup **30.2**

All carbon steel components/welds/HAZ
Pond water
100°F max, 125 psia design

Applies to BNL Part #s with prefix SS-SWCONT
1-56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Less likely in service water at low temperature	
2	Low	High	High	will depend on the precise environment and surface condition	
3	Medium	Medium	Medium	Can initiate from pits even at low temps	Pits, oxygen, water, impurities
4	Low	High	Medium	SCC certainly possible ,but unlikely at this low temperature. Specific conditions will be associated with off chemistry conditions that might lead to high concentrations of e.g. nitrate, plus oxygenated water. Uncertainty as to whether such conditions c	
5	Low	High	High	SCC can initiate at flaws such as pits, scratches	pits, mechanical flaws, high stress areas such as welds
6	Low	Medium	Medium	most likely at and near welds (i.e., high stress locations)	chlorides, sulphides, copper, etc. impurities required
7	Low	High	High	Well known phenomenon. Cl from insulation	Concern only if wet. Insulation material is critical
8	Low	High	High	Less likely than pitting or MIC	

Subgroup **31.1**

All stainless steel components
External surfaces at <130°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-CVXL
1-49

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time. Could be a big issue if high Cl, low pH, and with increasing temperature.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation (high pH is better) and temperature (higher is bad).

Subgroup **31.1**

All stainless steel components
External surfaces at <130°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-CVXL
1-49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time. Could be a big issue if high Cl, low pH, and with increasing temperature.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **31.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
3,13,19,28,38,41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High		Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **31.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
3,13,19,28,38,41

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Impurities and dissolved oxygen
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	SCC initiation in wrought SS (not HAZ) is difficult, and growth at 130F is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
8	0	High	High	SCC initiation in wrought SS (not HAZ) is difficult at any temperature (doubly so at 130F), and growth at 130F is very low	Impurities and dissolved oxygen

Subgroup **31.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
1,3,5,7,9,11,12,13,15,17,19,21,22,23,25,27,28,30,32,34,36,38,40,41,42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	Low	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Unless cyclic loads are high, should not be a problem.	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Unless cyclic loads are high, should not be a problem.	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **31.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
1,3,5,7,9,11,12,13,15,17,19,21,22,23,25,27,28,30,32,34,36,38,40,41,42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good field experience	Not anticipated to be significant in deoxygenated PWR water
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Good field experience - SCC initiation, even in HAZ, is difficult, and growth at 130F is very low. Some cracking may have occurred from chloride/sulfate. Cracking, if it occurs will be confined to a very narrow potential range at these temperatures	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High		Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Good field experience - SCC initiation, even in HAZ, is difficult at 130F, and growth at 130F is very low. Some cracking may have occurred from chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **31.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
4,6,8,10,14,16,18,20,24,26,29,31,33,35,37,39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **31.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
4,6,8,10,14,16,18,20,24,26,29,31,33,35,37,39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals in deoxygenated PWR primary water	Impurities and dissolved oxygen
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	Low	High	Medium	SCC initiation in SS weld is difficult, and growth at 130F is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 130F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **31.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
1,5,7,9,11,12,15,17,21,22,23,25,27,30,32,34,36,40,42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **31.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
1,5,7,9,11,12,15,17,21,22,23,25,27,30,32,34,36,40,42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS in deoxygenated PWR primary water	Impurities and dissolved oxygen
2	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	SCC initiation in SS weld is difficult, and growth at 130F is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS forgings at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 130F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **31.6**

Socket welds
Type 304, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
2

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	Medium	Medium	Medium	Significant field experience of failures at socket welds	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Group **31** **Support System**

CVCS Pump Piping to Crossover Leg/Injection

Subgroup **31.6**

Socket welds
Type 304, PWR primary water
130°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
2

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed PWR primary water chemistry	Impurities and dissolved oxygen
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	Long tern issue. Anions can concentrate in the crevice region of the joint and may go up to the level, which provides SCC condition	Impurities and dissolved oxygen. SCC may happen when CF problem is mitigated. CF>SCC
8	Low	High	High	SCC initiation in SS weld is difficult, and growth at 130F is very low, but could occur at low rate after fatigue initiates cracking.	Impurities and dissolved oxygen

Subgroup **31.7**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
45,48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Thermal fatigue conceivable and flow induced vibration a known problem	Depends on design detail and flow induced vibration
7	Low	High	High	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **31.7**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
45,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	High	SCC initiation in wrought SS is difficult, but growth at 557F may be possible	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry	Cold work and/or impurities and dissolved oxygen (neither of which are expected in PWR primary water)
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	SCC initiation in wrought SS is difficult, but growth at 557F is possible	Impurities and dissolved oxygen

Subgroup **31.8**

Austenitic weld HAZs
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
43,45,47,48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials and local strain may exacerbate	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Medium	Medium	Medium	Corrosion fatigue susceptibility after low temperature aging(LTA) is not clear.	Deoxygenated water effects on CF of austenitic materials a known issue. LTA effects is not clear yet.
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Group **31** **Support System**

CVCS Pump Piping to Crossover Connection

Subgroup **31.8**

Austenitic weld HAZs
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
43,45,47,48

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Even if toughness is degraded, still ductile and unlikely to pose a problem	Presence of defects, accident conditions
2	Medium	Low	Low	Known effect in cold worked material. Insufficient knowledge to dismiss.	
4	Low	High	Medium		
6	Low	Medium	Low	Not believed to be an issue, but data scarce	
8	Low	High	Medium	Concern for in-situ response of HAZ-strained material - both at 300C and lower temperature, and both for rapid fracture and J-R tearing resistance	

Subgroup **31.8**

Austenitic weld HAZs
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
43,45,47,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry	Cold work and/or impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	SCC initiation in SS HAZ is difficult, but growth rates at 557F in HAZ-strained material can be moderate in PWR primary water	Problems delayed by initiation and may be limited - but could be a significant generalized problem

Subgroup **31.9**

Austenitic to austenitic weld metals
Type 308, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
44,46

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Dead legs close to main coolant line potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	Medium	Medium	Unclear that lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **31.9**

Austenitic to austenitic weld metals
Type 308, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
44,46

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	High	Some concern for in-situ response, but lower than HAZ-strained material	Known issue. Effective prediction models.
5	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
6	Low	Medium	Medium	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
7	Medium	Medium	Medium	FR can be lowered after low temperature aging(LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Some concern for in-situ response, but lower than HAZ-strained material	Known issue. Effective prediction models. Oxidants, including concern for the addition of H2O2 during cooldown in PWRs

Subgroup **31.9**

Austenitic to austenitic weld metals
Type 308, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
44,46

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	High	Very good field experience - no known cracking due to SCC after extended operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
5	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging(LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Low	High	High	SCC initiation in SS weld metal is difficult, but growth at 557F is possible	Not anticipated to be a long term problem due to negligible dissolved oxygen.

Subgroup **31.10**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
43,47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Thermal fatigue a known problem and flow induced vibration conceivable	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **31.10**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
43,47
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	High	SCC initiation in forged SS is difficult, but growth at 557F is possible	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	SCC initiation in forged SS is difficult, but growth at 557F is possible. Much more concerned for cold worked and HAZ-strained material	Oxidants, including concern for the addition of H2O2 during cooldown in PWRs

Subgroup **31.11**

Socket welds
Type 304, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
49

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	High	High	Medium	Significant field experience of failures	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **31.11**

Socket welds
Type 304, PWR primary water
557°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVXL
49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 557F in HAZ-strained material is possible. corrosion fatigue is dominant mode.	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	Medium	Medium	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC. In general, CF susceptibility>SCC
8	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 557F in HAZ-strained material is possible. corrosion fatigue is dominant mode -- although after initiation by corrosion fatigue, the distinction between SCC and corrosion fatigue at high load ratio can be small	Oxidants, including concern for the addition of H2O2 during cooldown in PWRs

Subgroup **31.12**

Flange retaining bolts
SA-194 Gr B16
Building Air
Low temperature

Applies to BNL Part #s with prefix SS-CVXL
11
Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	Low	High	High	Will only be problem if there is a gasket leak	
5	Low	High	High	Can occur only if flange leaks and leakage allowed to dry out and deposit on pipe surface	Not a significant future threat if flange leaks prevented and deposits cleaned off.
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Group **31** **Support System**

CVCS Pump Piping to Crossover Leg/Injection

Subgroup **31.12**

Flange retaining bolts
SA-194 Gr B16
Building Air
Low temperature

Applies to BNL Part #s with prefix SS-CVXL
11
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
7	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.

Subgroup **31.12**

Flange retaining bolts
SA-194 Gr B16
Building Air
Low temperature

Applies to BNL Part #s with prefix SS-CVXL
11
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	Low	High	High	Should not be a problem if tech specs on yield stress are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data for reduction of FR in this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen entry
8	Low	High	High	Could be problem if leaks occur	

Subgroup **31.12**

Flange retaining bolts
SA-194 Gr B16
Building Air
Low temperature

Applies to BNL Part #s with prefix SS-CVXL
11
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	High	Medium	Has occurred but not since molybdenum disulfide lubricants were banned	Oxidants, including concern for the addition of H2O2 during cooldown in PWRs. Intermediate temp. exposure can accelerate initiation.

Subgroup **32.1**

All stainless steel components
External surfaces at <557°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-CVLD
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,35

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Pipe is at 560F except during shutdown, so surface is dry	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation (high pH is better) and temperature (higher is bad).

Subgroup **32.1**

All stainless steel components
External surfaces at <557°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-CVLD
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,35

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Pipe is at 560F except during shutdown, so surface is dry	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **32.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
4,32

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Thermal fatigue conceivable and flow induced vibration a known problem	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **32.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
4,32
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	High	SCC initiation in wrought SS is difficult, and growth at 560F is slow	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry for higher temperatures	Cold work and/or impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	SCC initiation in wrought SS is difficult, and growth at 560F is slow	Impurities and dissolved oxygen

Subgroup **32.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
2,4,6,8,9,12,14,16,18,19,21,32,33,34

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials and local strain may exacerbate	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Medium	Medium	Medium	Corrosion fatigue susceptibility after low temperature aging(LTA) is not clear.	Deoxygenated water effects on CF of austenitic materials a known issue. LTA effects is not clear yet.
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **32.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
2,4,6,8,9,12,14,16,18,19,21,32,33,34

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Even if toughness is degraded, still ductile and unlikely to pose a problem	Presence of defects, accident conditions
2	Medium	Low	Low	Known effect in cold worked material. Insufficient knowledge to dismiss.	
4	Low	High	Medium	Expected response of HAZ, associated with strain concentration	
6	Low	Medium	Low	Not believed to be an issue, but data scarce	
7	Low	Medium	Medium	SCC may take place during start up/shut down period after LTA	LTA and hydrogen during s-u/s-d
8	Low	High	Medium	Concern for in-situ response of HAZ-strained material - both at 300C and lower temperature, and both for rapid fracture and J-R tearing resistance	

Subgroup **32.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
2,4,6,8,9,12,14,16,18,19,21,32,33,34

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry for higher temperatures	Cold work and/or impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	SCC initiation in SS HAZ is difficult, but growth rates at 557F in HAZ-strained material can be moderate in PWR primary water	Problems delayed by initiation and may be limited - but could be a significant generalized problem

Subgroup **32.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
1,3,5,7,10,11,15,17,20,23,24,25,26,27,28,29,30,31

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Low	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **32.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
1,3,5,7,10,11,15,17,20,23,24,25,26,27,28,29,30,31

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
5	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
6	Low	Medium	Medium	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
7	Medium	Medium	Medium	FR can be lowered after low temperature aging(LTA).	LTA and hardening can cause SCC under some certain condition
8	Low	High	High	Some concern for in-situ response, but lower than HAZ-strained material	Known issue. Effective prediction models.

Subgroup **32.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
1,3,5,7,10,11,15,17,20,23,24,25,26,27,28,29,30,31

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	High	SCC initiation in SS weld metal is difficult, but growth at 560F is possible	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	Medium	Medium	Impurities and dissolved oxygen, neither of which are expected in PWR primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging(LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Low	High	High	SCC initiation in SS weld metal is difficult, but growth at 560F is possible	Impurities and dissolved oxygen

Subgroup **32.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
2,6,8,9,12,14,16,18,19,21,33,34

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Low	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Thermal fatigue a known problem and flow induced vibration conceivable	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **32.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
2,6,8,9,12,14,16,18,19,21,33,34

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Medium	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses. Consider mandrils and possible effect on inside surfaces
4	Low	High	High	SCC initiation in forged SS is difficult, but growth at 560F is possible	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry for higher temperatures	Impurities and dissolved oxygen
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	SCC initiation in forged SS is difficult, but growth at 560F is possible. Much more concerned about HAZ and cold formed components.	Impurities and dissolved oxygen

Subgroup **32.6**

Socket welds
Type 304, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
13.22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	High	High	Medium	Significant field experience of failures	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **32.6**

Socket welds
Type 304, PWR primary water
115 to 560°F, 2250 psia

Applies to BNL Part #s with prefix SS-CVLD
13.22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 560F in HAZ-strained material is possible. corrosion fatigue is dominant mode.	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 560F in HAZ-strained material is possible. corrosion fatigue is dominant mode.	Impurities and dissolved oxygen

Subgroup **33.1**

All stainless steel components
External surfaces at <290°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RHXLHX

1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.20.21.22.23.24.25.26.27.28.29.30.31.32.33.34.35.36.37.38.39.40.41.42.43.44.45.46.47.48.49. 50.54

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols. the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols. the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols. the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Pipe is at 290F except during shutdown - unlikely to have liquid phase at 290F and atm pressure.	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Problems could occur during shutdown.

Subgroup **33.1**

All stainless steel components
External surfaces at <290°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RHXLHX

1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.20.21.22.23.24.25.26.27.28.29.30.31.32.33.34.35.36.37.38.39.40.41.42.43.44.45.46.47.48.49. 50.54

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols. the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols. the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols. the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Pipe is at 290F except during shutdown	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **33.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
3,23,32,55,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Group **33** **Support System** **CVCS Regenerative HX Piping to 304/304 HX**

Subgroup **33.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
3,23,32,55,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Impurities and dissolved oxygen
2	Low	High	High	Unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	Low	High	High	SCC initiation in wrought SS (not HAZ) is difficult, and growth at 290F is low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
8	Low	High	High	SCC initiation in wrought SS (not HAZ) is difficult, and growth at 290F is low	Impurities and dissolved oxygen

Subgroup **33.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
3.5.7.9.11.12.14.17.19.22.23.25.29.31.32.35.38.40.41.43.45.46.48.49.54.55.56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **33.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
3.5.7.9.11.12.14.17.19.22.23.25.29.31.32.35.38.40.41.43.45.46.48.49.54.55.56

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	Probably not an issue at these temperatures	
4	Low	High	High	Concern for in-situ response of HAZ-strained SS	
6	0	Medium	Medium	Not expected to be an issue at this temperature	
8	Low	High	High	Concern for in-situ response of HAZ-strained material - both at 300C and lower temperature, and both for rapid fracture and J-R tearing resistance	

Subgroup **33.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
3.5.7.9.11.12.14.17.19.22.23.25.29.31.32.35.38.40.41.43.45.46.48.49.54.55.56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good field experience	Not anticipated to be significant in deoxygenated PWR water
2	Low	High	High	Unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Medium	High	High	SCC initiation in SS HAZ is difficult, but growth at 290F in HAZ-strained material is possible	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Medium	High	Medium	SCC initiation in SS HAZ is difficult, but growth rates at 290F in HAZ-strained material might be moderate in PWR primary water	Problems delayed by initiation and may be limited - but could be a significant generalized problem. SCC accelerated by oxidants, including concern for the addition of H2O2 during cooldown in PWRs

Subgroup **33.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
1.2.4.6.10.13.15.16.18.20.21.24.26.27.28.30.33.34.36.37.39.42.44.47.50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **33.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
1.2.4.6.10.13.15.16.18.20.21.24.26.27.28.30.33.34.36.37.39.42.44.47.50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals in deoxygenated PWR primary water	Impurities and dissolved oxygen
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC for weld metal at 115F, but may at 290F. However growth rate is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	Low	High	High	SCC initiation in SS weld metal is difficult, but growth at 290F is possible	Impurities and dissolved oxygen

Subgroup **33.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
5.7.9.11.12.14.17.19.22.25.29.31.35.38.40.41.43.45.46.48.49.54

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration occurs during use
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **33.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
5.7.9.11.12.14.17.19.22.25.29.31.35.38.40.41.43.45.46.48.49.54

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS in deoxygenated PWR primary water	Impurities and dissolved oxygen
2	Low	High	High	Unlikely at this temperature	Impurities and dissolved oxygen
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS unless severely surface damaged.	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	Low	High	High	SCC initiation in forged SS is difficult, but growth at 290F is possible	Impurities and dissolved oxygen

Subgroup **33.6**

Socket welds
Type 304, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
6,8

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	Medium	Medium	Medium	Significant field experience of failures at socket welds	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **33.6**

Socket welds
Type 304, PWR primary water
115 to 290°F, 285 to 2235 psia

Applies to BNL Part #s with prefix SS-RHXLHX
6,8

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed PWR primary water chemistry	Impurities and dissolved oxygen
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	Long tern issue. Anions can concentrate in the crevice region of the joint and may go up to the level, which provides SCC condition	Impurities and dissolved oxygen. SCC may happen when CF problem is mitigated. CF>SCC
8	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 290F in HAZ-strained material is possible. corrosion fatigue is dominant mode, but once initiation occurs, corrosion fatigue and SCC can be difficult to distinguish at high R	Impurities and dissolved oxygen

Subgroup **33.7**

Letdown HX shell, nozzles & fittings
Carbon steel
Treated water (CCW)
105 to 137°F, 150 psia

Applies to BNL Part #s with prefix SS-RHXLHX
51.52.53
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion/galvanic corrosion common in carbon steels exposed to CCW water; dependent on conductivity and water softness	Coupling to SS typically at flanges/gaskets; corrosion under deposits; threaded components
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Crevices present
4	Low	High	High	Only a problem if the water chemistry specs are not met	
5	Low	High	High	Can occur under deposits or at mechanical joints if corrosive impurities or oxidizing conditions present.	Contamination, including highly oxidizing conditions
6	Low	Medium	Medium	Possible susceptibility in quasi-stagnant areas	Impurities and dissolved oxygen
7	Low	High	High	Corrosion product may form crevice	
8	Low	High	High		

Subgroup **33.7**

Letdown HX shell, nozzles & fittings
Carbon steel
Treated water (CCW)
105 to 137°F, 150 psia

Applies to BNL Part #s with prefix SS-RHXLHX
51.52.53
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely to be a big effect of environment on fatigue in properly treated water	Failure of water treatment procedures leading to localized corrosion and easier initiation of fatigue cracking
2	Medium	High	High	well-known phenomenon; requires cyclic stress	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High		
5	Low	High	High	Can occur at highly stressed (e.g. welds) or cold-worked areas subject to cyclic operating stresses	Contamination, including highly oxidizing conditions
6	Low	Medium	Medium	Thermal fatigue unlikely at this temperature	
7	Low	High	High	Potential problem of CS at these low temperature	Stress can be caused by vibration.
8	Low	High	High	Expect no large cyclic loads	

Subgroup **33.7**

Letdown HX shell, nozzles & fittings
Carbon steel
Treated water (CCW)
105 to 137°F, 150 psia

Applies to BNL Part #s with prefix SS-RHXLHX
51.52.53
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC shouldn't occur in properly treated water	Areas where deposits may accumulate. Absence of oxygen and presence of nutrients
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes, low velocities
4	Low	High	High	Only a problem if the water chemistry specs are not met	
5	Low	High	High	Can occur if conditions allow deposits to form, including slime deposits. Unlikely in treated water, but has been seen in ECC systems.	Contamination, including highly oxidizing conditions and/or bacteria
6	Medium	Medium	Medium	Possible susceptibility in quasi-stagnant areas	Impurities and dissolved oxygen
7	Low	High	High	Assume treated water and monitor	
8	Low	High	High	Problems could develop quickly if water treatment is not properly maintained	

Subgroup **33.7**

Letdown HX shell, nozzles & fittings
Carbon steel
Treated water (CCW)
105 to 137°F, 150 psia

Applies to BNL Part #s with prefix SS-RHXLHX
51.52.53
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting shouldn't occur in properly treated water	Areas where deposits may accumulate. Systems that are periodically flushed with aerated water.
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Low	Medium	Medium	Conditions for pitting most likely during shutdown.	Occur especially with oxygen
4	Low	High	High	Only a problem if the water chemistry specs are not met	
5	Low	High	High	Can occur at mechanical defects (scratches) or under deposits if corrosive impurities present.	Contamination, including highly oxidizing conditions
6	Low	Medium	Medium	Possible susceptibility in quasi-stagnant areas	Impurities and dissolved oxygen
7	Low	High	High	Local environmental change due to deposit, scratch etc can assist pits formation	Water chemistry, anions and oxygen
8	Low	High	High		

Subgroup **33.7**

Letdown HX shell, nozzles & fittings
Carbon steel
Treated water (CCW)
105 to 137°F, 150 psia

Applies to BNL Part #s with prefix SS-RHXLHX
51.52.53
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known SCC mechanisms in properly treated water	
2	Low	High	High	unlikely at this temperature	
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits.
4	Low	High	High		
5	Low	High	High	Can occur at highly stressed (e.g. welds) or cold-worked areas	Contamination, including highly oxidizing conditions
6	Low	Medium	Medium	SCC unlikely at this temperature except with gross contamination	Impurities and dissolved oxygen
7	Low	High	High	Potential problem of CS at these low temperature	High static stress required
8	Low	High	High		

Subgroup **34.1**

All stainless steel components
External surfaces at <115°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-LHXVCT

1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,49,50,51,52,53

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **34.1**

All stainless steel components
External surfaces at <115°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-LHXVCT

1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,49,50,51,52,53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **34.2**

Wrought austenitic stainless steel piping (≤3" NPS)
Types 304, 316, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
4,10

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **34.2**

Wrought austenitic stainless steel piping (≤3" NPS)
Types 304, 316, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
4,10

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Unlikely to initiate SCC for wrought piping at 115F, and growth rate is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
8	0	High	High	Unlikely to initiate SCC for wrought piping at 115F, and growth rate is very low	Impurities and dissolved oxygen

Subgroup **34.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
2,4,6,8,10,11,14,16,18,21,22,23,24,26,28,29,32,34,35,38,39,40,41,42,43

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **34.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
2,4,6,8,10,11,14,16,18,21,22,23,24,26,28,29,32,34,35,38,39,40,41,42,43

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely here than elsewhere	Exposure to H2O2 during PWR cooldown could exacerbate a very low probability issue.

Subgroup **34.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
1,3,9,12,13,15,17,19,20,27,30,31,36,37,44,45,46,47,49,50,51,52,53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **34.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
1,3,9,12,13,15,17,19,20,27,30,31,36,37,44,45,46,47,49,50,51,52,53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 115F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **34.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
2,6,8,11,14,16,18,21,22,23,24,26,28,29,32,34,35,38,39,40,41,42,43
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **34.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
2,6,8,11,14,16,18,21,22,23,24,26,28,29,32,34,35,38,39,40,41,42,43

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS unless very severely surface damaged	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 115F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **34.6**

Socket welds
Type 304, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
5,7,19

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	Medium	Medium	Medium	Significant field experience of failures at socket welds	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **34.6**

Socket welds
Type 304, PWR primary water
115°F, 75 or 285 psia

Applies to BNL Part #s with prefix SS-LHXVCT
5,7,19

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	Long tern issue. Anions can concentrate in the crevice region of the joint and may go up to the level, which provides SCC condition	Impurities and dissolved oxygen. SCC may happen when CF problem is mitigated. CF>SCC
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen

Subgroup **34.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 or B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
1,21,25

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	0	High	High	Even if leakage onto joint occurs, no boiling will occur to concentrate boric acid	
5	Low	High	High	Can occur only if flange leaks and leakage allowed to dry out and deposit on pipe surface	Not a significant future threat if flange leaks prevented and deposits cleaned off.
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Subgroup **34.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 or B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
1,21,25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High	Only possible if leakage onto joint	
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
7	Low	High	High	Assume small stress amplitude	Only after leak
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **34.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 or B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
1,21,25

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen entry
8	Low	High	High	Could be problem if leaks occur	

Subgroup **34.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 or B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
1,21,25

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in air	
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	If moisture present GC would occur. The hydrogen produced in GC would exacerbate SCC.	Moisture
4	Low	High	High	Only possible if leakage onto joint	
5	Low	High	High	Can occur only if surfaces wet or alternately wet/dry	Not considered a significant future threat.
6	0	Medium	Medium	Not expected, unless comes into contact with boric acid	
7	Low	High	High	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **34.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 or B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
1,21,25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Only possible if leakage onto joint	
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	
7	Low	High	High	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **34.8**

Bolted flanged joint
Studs SA453 Gr 660 (13-16% CR SS)
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High	Only possible if leakage onto joint	
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode if severe stresses present (or cold work)	Not considered a significant future threat.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
7	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **34.8**

Bolted flanged joint
Studs SA453 Gr 660 (13-16% CR SS)
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
48

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen enry
8	Low	High	High	Might be small problem if leaks occur	

Subgroup **34.8**

Bolted flanged joint
Studs SA453 Gr 660 (13-16% CR SS)
Building air environment

Applies to BNL Part #s with prefix SS-LHXVCT
48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC not a threat if heat treated correctly. Initiation facilitated if chloride present	Presence of surface contamination and moisture
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Only possible if leakage onto joint	
5	Low	High	High	Possible if corrosive environment and high stresses present	
6	Medium	High	High	A potential issue if contaminants promote H2 ingress	
7	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
8	Low	High	High	Possibility of some leakage onto bolts	

Group **35** **Support System**

CVCS Mixed Bed Piping Filter

Subgroup **35.1**

All stainless steel components
External surfaces at <115°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-MBFTR
1-48

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **35.1**

All stainless steel components
External surfaces at <115°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-MBFTR
1-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **35.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
4,23,24 (cold worked)

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **35.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
4,23,24 (cold worked)

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC for wrought piping at 115F, and growth rate is very low. Scoring for Susceptibility increased due to CW	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at this temperature in the absence of impurities	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS. Cold work may form martensite potentially increasing SCC susceptibility	Impurities and dissolved oxygen and cold work
8	0	High	High	Very unlikely to initiate SCC for forged SS at 160F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **35.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
2,4,6,8,9,12,15,16,17,19,21,23,24,26,28,30,31,36,37,38,39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **35.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
2,4,6,8,9,12,15,16,17,19,21,23,24,26,28,30,31,36,37,38,39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely here than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely here than elsewhere. Some concern for H2O2 additions during shutdown	

Subgroup **35.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
1,3,5,7,10,11,14,18,20,22,25,27,29,32,33,34,35,40,41,42,43,44,45,46,47,48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **35.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
1,3,5,7,10,11,14,18,20,22,25,27,29,32,33,34,35,40,41,42,43,44,45,46,47,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 115F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **35.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115°F, 75 to 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
2,6,15,19,21,26,28,31

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **35.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
115°F, 75 to 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
2,6,15,19,21,26,28,31

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS unless very severely surface damaged	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 115F, and growth rate is very low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **35.6**

Socket welds
Type 304, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
14

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	Medium	Medium	Medium	Significant field experience of failures at socket welds	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **35.6**

Socket welds
Type 304, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
14

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	0	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	Long tern issue. Anions can concentrate in the crevice region of the joint and may go up to the level, which provides SCC condition	Impurities and dissolved oxygen. SCC may happen when CF problem is mitigated. CF>SCC
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen

Subgroup **35.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-MBFTR
26

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	0	High	High	Even if leakage onto joint occurs, no boiling will occur to concentrate boric acid	
5	Low	High	High	Can occur only if flange leaks and leakage allowed to dry out and deposit on pipe surface	Not a significant future threat if flange leaks prevented and deposits cleaned off.
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Subgroup **35.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-MBFTR
26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
7	Low	High	Medium	Source of vibration stress is not clear	
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **35.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-MBFTR
26

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen entry
8	Low	High	High	Could be problem if leaks occur	

Subgroup **35.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-MBFTR
26

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	If moisture present GC would occur. The hydrogen produced in GC would exacerbate SCC.	Moisture
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	High	Can occur only if surfaces wet or alternately wet/dry	Not considered a significant future threat.
6	0	Medium	Medium	Not expected, unless comes into contact with boric acid	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **35.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-MBFTR
26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **35.8**

Cast austenitic SS components
Types CF8, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
8,9,12,17,30,36,37,38,39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	cast components are usually overdimensioned and thus should not be prone to vibrational fatigue, temperature too low for thermal fatigue concerns	
3	Low	Medium	Medium	May be affected by variations in metallurgy and discontinuities in casting	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	High	Expect no large cyclic loads	
5	Medium	High	High	Some field experience; aging issues	Can be managed
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Source of vibration stress is not clear	
8	Low	High	High	Expect no large cyclic loads	

Subgroup **35.8**

Cast austenitic SS components
Types CF8, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
8,9,12,17,30,36,37,38,39

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Thermal aging not an issue at 115°F	
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Low	Medium	Medium	The aging of cast stainless steels produces uncertainties but the fracture resistance is lowered. It is not clear how this issue is a problem for longer times. No sense of statistical distribution of fracture resistance with metallurgical variables	Most likely incided when defects are present. Possible pitting due to metallurgical defects.
4	Low	High	Medium	Aging kinetics probably not enough to give problem at this temperature. Lowered Knowledge score to account for composition effect uncertainties (see CASS topical)	
5	--	Low	Low	Aging/cold work?	Need more knowledge
6	0	High	High	Well-characterized phenomenon	No effect expected at this temperature
7	Low	High	High	Temperature I slow enough not causing thermal aging	
8	Low	High	High	Could be a small problem if leaks occur	

Subgroup **35.8**

Cast austenitic SS components
Types CF8, PWR primary water
115°F, 285 psia

Applies to BNL Part #s with prefix SS-MBFTR
8,9,12,17,30,36,37,38,39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis from laboratory data or field experience to expect SCC initiation in cast duplex SS in deoxygenated PWR primary water in absence of thermal aging	Impurities and dissolved oxygen
2	0	High	Medium	not a concern at this temperature	
3	Low	Medium	Low	While there seems to be some confidence in this subject by others, I don't think that the work has been thoroughly done.	Subject needs review
4	0	High	High	No aging, low temperature	
5	Medium	Low	Low	Apparently some concerns if impurities and/or oxidizing conditions present	Need more knowledge
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in cast SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	Temperature I slow enough not causing thermal aging	
8	0	High	High	No aging, low temperature	

Subgroup **35.9**

Dissimilar metal weld (Support lug)
External surface
Auxiliary building air

Applies to BNL Part #s with prefix SS-MBFTR
13

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from aerosols, the latter increasing with time	Concern only if wet.
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Presence of pitting depends on moisture and some contamination. Absent this, no pitting	Moisture, impurities
4	Low	High	High	Possible external SCC if wet	
5	Low	High	High	Can occur if surface can be wet or alternately wet/dry and oxidizing conditions/contaminants present	Not a life limiting issue
6	Low	Medium	Medium	Not expected in absence of gross contamination	
7	Medium	Medium	Medium	Cl concentration at the surface of dissimilar metal weld can cause pit	Bldg air can contain an enough Cl.
8	Low	High	High	Possible external pitting if wet	

Subgroup **35.9**

Dissimilar metal weld (Support lug)
External surface
Auxiliary building air

Applies to BNL Part #s with prefix SS-MBFTR
13

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from aerosols, the latter increasing with time	Concern only if wet.
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Temperatures too low for SCC	Very high stresses
4	Low	High	High	Possible external SCC if wet	
5	Medium	High	High	Possible when contaminants and/or wet or wet/dry conditions present. High stresses in weld likely focus (or pits).	Unlikely to be an issue if surfaces kept clean.
6	Low	Medium	Medium	Not expected in absence of gross contamination	
7	Medium	Medium	Medium	Cl concentration at the surface of dissimilar metal weld and wet condition can cause SCC	Bldg air can contain an enough Cl.
8	Low	High	High	Possible external SCC if wet	

Subgroup **36.1**

All stainless steel components
External surfaces at <160°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-VCTCVP
1-70

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Suction

Subgroup **36.1**

All stainless steel components
External surfaces at <160°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-VCTCVP
1-70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed, but problems if wetted, more acidic, higher temperature	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **36.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
3,19,56 (cold worked),61,68 (cold worked)

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **36.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
3,19,56 (cold worked),61,68 (cold worked)

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC for wrought piping at 115F, and growth rate is very low and in a very narrow potential range. Scoring for Susceptibility increased due to CW	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS. Cold work may form martensite potentially increasing SCC susceptibility	Impurities and dissolved oxygen and cold work
8	0	High	High	Very unlikely to initiate SCC for wrought piping at 160F, and growth rate is very low; but cold bending could cause problems	Impurities and dissolved oxygen

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Suction

Subgroup **36.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
2,3,5,7,11,13,15,17,19,24,34,35,36,40,44,49,50,55,56,58,59,61,62,64,65,67,68,69,70

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Location

Subgroup **36.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
2,3,5,7,11,13,15,17,19,24,34,35,36,40,44,49,50,55,56,58,59,61,62,64,65,67,68,69,70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 115F is low -- but more likely in HAZ and at 160F	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 160F is low -- but more likely here than elsewhere. Adding H2O2 during shutdown could aggravate concern	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Location

Subgroup **36.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
1,4,6,8,10,12,14,16,18,20,21,23,25,26,27,28,29,30,32,33,37,39,42,43,45,46,47,48,53,57,60,63,66

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **36.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
1,4,6,8,10,12,14,16,18,20,21,23,25,26,27,28,29,30,32,33,37,39,42,43,45,46,47,48,53,57,60,63,66

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen

Subgroup **36.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
2,5,7,11,13,15,17,24,34,35,36,40,44,49,50,55,58,59,62,64,65,67,69,70

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **36.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
2,5,7,11,13,15,17,24,34,35,36,40,44,49,50,55,58,59,62,64,65,67,69,70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 160F, and growth rate is low. Could be a problem with cold work, higher stresses, and esp. if H2O2 added (as occurs during shutdown).	Impurities and dissolved oxygen

Subgroup **36.6**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-VCTCVP
39.58

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	0	High	High	Even if leakage onto joint occurs, no boiling will occur to concentrate boric acid	
5	Low	High	High	Can occur only if flange leaks and leakage allowed to dry out and deposit on pipe surface	Not a significant future threat if flange leaks prevented and deposits cleaned off.
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Subgroup **36.6**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-VCTCVP
39.58

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	no cyclic loading mode	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High		
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
7	Low	High	Medium	Source of vibration stress is not clear	
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **36.6**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-VCTCVP
39.58

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen entry
8	Low	High	High	Could be problem if leaks occur	

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Suction

Subgroup **36.6**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-VCTCVP
39.58

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	If moisture present GC would occur. The hydrogen produced in GC would exacerbate SCC.	Moisture
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	High	Can occur only if surfaces wet or alternately wet/dry	Not considered a significant future threat.
6	0	Medium	Medium	Not expected, unless comes into contact with boric acid	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Location

Subgroup **36.6**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-VCTCVP
39.58

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Group **36** **Support System**

CVCS VCT Piping to Charging Pump Location

Subgroup **36.7**

Cast austenitic
Types CF8, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
9,22,31,41,51,52,54

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
2	0	High	Medium	cast components are usually overdimensioned and thus should not be prone to vibrational fatigue, temperature too low for thermal fatigue concerns	
3	Low	Medium	Medium	May be affected by variations in metallurgy and discontinuities in casting	Presumably requires some defect as initiation site. However, initiation may relate to reactivity of metallurgical defects.
4	Low	High	High	Expect no large cyclic loads	
5	Medium	High	High	Some field experience; aging issues	Can be managed
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Source of vibration stress is not clear	
8	Low	High	High	Expect no large cyclic loads	

Subgroup **36.7**

Cast austenitic
Types CF8, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
9,22,31,41,51,52,54

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Thermal aging not an issue at 115 or 160°F	
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Low	Medium	Medium	The aging of cast stainless steels produces uncertainties but the fracture resistance is lowered. It is not clear how this issue is a problem for longer times. No sense of statistical distribution of fracture resistance with metallurgical variables	Most likely incided when defects are present. Possible pitting due to metallurgical defects.
4	Low	High	Medium	Aging kinetics probably not enough to give problem at this temperature. Lowered Knowledge score to account for composition effect uncertainties (see CASS topical)	
5	--	Low	Low	Aging/cold work?	Need more knowledge
6	0	High	High	Well-characterized phenomenon	No effect expected at this temperature
7	Low	High	High	Temperature I slow enough not causing thermal aging	
8	Low	High	High	Could be a minor problem if leaks occur	

Subgroup **36.7**

Cast austenitic
Types CF8, PWR primary water
160 or 115°F, 95 or 2250 psia

Applies to BNL Part #s with prefix SS-VCTCVP
9,22,31,41,51,52,54

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis from laboratory data or field experience to expect SCC initiation in cast duplex SS in deoxygenated PWR primary water in absence of thermal aging	Impurities and dissolved oxygen
2	0	High	Medium	not a concern at this temperature	
3	Low	Medium	Low	While there seems to be some confidence in this subject by others, I don't think that the work has been thoroughly done.	Subject needs review
4	0	High	High	No aging, too low a temperature	
5	Medium	Low	Low	Apparently some concerns if impurities and/or oxidizing conditions present	Need more knowledge
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in cast SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	Assume primary water and tremprtature is low to cause SCC	
8	0	High	High	No aging, low temperature	

Subgroup **37.1**

All stainless steel components
External surfaces at <130°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-CHPRHX
1-53

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **37.1**

All stainless steel components
External surfaces at <130°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-CHPRHX
1-53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **37.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
11,28,42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **37.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
11,28,42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at these low temperatures	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC at 130F, and growth rate is very low.	Impurities and dissolved oxygen

Subgroup **37.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
2,5,8,10,11,13,15,19,22,24,25,27,28,31,34,36,37,38,40,41,42,44,47,49,51,52

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **37.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
2,5,8,10,11,13,15,19,22,24,25,27,28,31,34,36,37,38,40,41,42,44,47,49,51,52

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely in HAZ than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely here than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Group **37** **Support System**

CVCS Charging Pump Piping to Regen Heat HX

App.E.4 - All PWR Scores

Subgroup **37.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
1,3,4,6,7,9,16,17,18,20,21,23,26,29,30,32,33,35,39,43,45,46,48,50,53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **37.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
1,3,4,6,7,9,16,17,18,20,21,23,26,29,30,32,33,35,39,43,45,46,48,50,53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation and growth in SS weld metals at these low temperatures	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC at 130F, and growth rate is very low.	Impurities and dissolved oxygen

Group **37** **Support System**

CVCS Charging Pump Piping to Regenerative HX

App.E.4 - All PWR Scores

Subgroup **37.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
2,5,8,10,13,15,19,22,24,25,27,31,34,36,37,38,40,41,44,47,49,51,52

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **37.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
2,5,8,10,13,15,19,22,24,25,27,31,34,36,37,38,40,41,44,47,49,51,52

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	Unlikely to initiate SCC for forged SS at 130F, and growth rate is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	0	High	High	Very unlikely to initiate SCC for forged SS at 130F, and growth rate is very low	Impurities and dissolved oxygen

Group **37** **Support System**

CVCS Charging Pump Piping to Regen HX

Subgroup **37.6**

Socket welds
Type 304, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
12.14

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	Medium	Medium	Medium	Significant field experience of failures at socket welds	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Group **37** **Support System**

CVCS Charging Pump Piping to Regenerative HX

Subgroup **37.6**

Socket welds
Type 304, PWR primary water
130°F, 2235 psia

Applies to BNL Part #s with prefix SS-CHPRHX
12.14

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	Long tern issue. Anions can concentrate in the crevice region of the joint and may go up to the level, which provides SCC condition	Impurities and dissolved oxygen. SCC may happen when CF problem is mitigated. CF>SCC
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen

Group **37** **Support System**

CVCS Charging Pump Piping to Regen Heat HX

App.E.4 - All PWR Scores

Subgroup **37.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-CHPRHX
34

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	0	High	High	Even if leakage onto joint occurs, no boiling will occur to concentrate boric acid	
5	Low	High	High	Can occur only if flange leaks and leakage allowed to dry out and deposit on pipe surface	Not a significant future threat if flange leaks prevented and deposits cleaned off.
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Group **37** **Support System**

CVCS Charging Pump Piping to Regen Heat HX

App.E.4 - All PWR Scores

Subgroup **37.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-CHPRHX
34

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	High	Can occur only if surfaces wet or alternately wet/dry	Not considered a significant future threat.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **37.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-CHPRHX
34

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen entry
8	Low	High	High	Could be problem if leaks occur	

Group **37** **Support System**

CVCS Charging Pump Piping to Regen HX

Subgroup **37.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-CHPRHX
34

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in air	
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	If moisture present GC would occur. The hydrogen produced in GC would exacerbate SCC.	Moisture
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	0	Medium	Medium	Not expected, unless comes into contact with boric acid	
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Possibility of some leakage onto bolts	

Group **37** **Support System**

CVCS Charging Pump Piping to Regenerative HX

Subgroup **37.7**

Bolted flanged joint
Flange bolts SA193 Gr B7 bolts
Building air environment

Applies to BNL Part #s with prefix SS-CHPRHX
34

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Group **38** **Support System**

CVCS Regenerative HX Piping Cold Leg
App.E.4 - All PWR Scores

Subgroup **38.1**

All stainless steel components
External surfaces at <517°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RHXCL
1-24

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **38.1**

All stainless steel components
External surfaces at <517°F
Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RHXCL
1-24

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **38.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
6,19

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **38.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
6,19

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	High	SCC initiation in wrought SS is difficult, and growth at 517F is slow	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry	Cold work and/or impurities and dissolved oxygen (neither of which are expected in PWR primary water)
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	SCC initiation in wrought SS is difficult, and growth at 517F is slow	Impurities and dissolved oxygen

Subgroup **38.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
2,5,6,8,9,12,15,17,19,20,21,22,23

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Corrosion fatigue for HAZs is not well defined but service experience is good. Further, corrosion fatigue probably would exert its main influence through the ripple effect on SCC. Initiation would be affected by abusive surface machining and by residual stresses.	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials and local strain may exacerbate	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Medium	Medium	Medium	Corrosion fatigue susceptibility after low temperature aging(LTA) is not clear.	Deoxygenated water effects on CF of austenitic materials a known issue. LTA effects is not clear yet.
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Group **38** **Support System**

CVCS Regenerative HX Piping Cold Leg

App.E.4 - All PWR Scores

Subgroup **38.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
2,5,6,8,9,12,15,17,19,20,21,22,23

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Even if toughness is degraded, still ductile and unlikely to pose a problem	Presence of defects, accident conditions
2	Medium	Low	Low	Known effect in cold worked material. Insufficient knowledge to dismiss.	
4	Low	High	Medium	Effect of In-situ response of HAZ-strained material not fully quantified	
6	Low	Medium	Low	Not believed to be an issue, but data scarce	
7	Low	Medium	Medium	SCC may tame place during start up/shut down period after LTA	LTA and hydrogen during s-u/s-d
8	Low	High	Medium	In-situ response of HAZ-strained material	

Subgroup **38.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
2,5,6,8,9,12,15,17,19,20,21,22,23

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Significant information on initiation and propagation of SCC in weld HAZ is not available for the range of microstructures and chemistries in HAZs with respect to the low potential conditions of PWRs . However field experience is good. Evidence from INSS	For both SCC and corrosion fatigue SCC will be accelerated by abusive machining and low cyclic frequencies as well as high residual stresses.
4	Medium	High	High	SCC initiation in SS HAZ is difficult, but growth at 517F in HAZ-strained material is possible	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry	Cold work and/or impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	Not anticipated to be a long term problem due to negligible dissolved oxygen but LTA and hardening can cause SCC under some certain condition
8	Medium	High	High	SCC initiation in SS HAZ is difficult, but growth at 517F in HAZ-strained material is possible	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **38.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
1,3,4,7,10,11,13,16,18,24

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	Medium	Low	Performance in the field has been generally good. No significant information of conditions and dependencies for corrosion fatigue. It is most likely that corrosion fatigue acts as it stimulates the SCC through the ripple effect especially when the cyclic frequency is 1 Hz or less.	Special conditions for surface effects on initiation due to abusive grinding. Residual stresses superimposed.
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	Medium	Medium	Dissimilar expansion coeffs + possible environmental effects	Good field experience so far. Only likely to be a problem where present nominal CUF>0.1approx.
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **38.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
1,3,4,7,10,11,13,16,18,24

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
3	Low	Medium	Low	The Mills effect (loss of toughness at low temperatures especially for Alloy 690) seems to apply less at high temperature than at lower temperatures. However, this effect has not been adequately explored with respect to alloys and temperature, metallurgy	Domains of alloy, temperature, stress are not clear and need to be specified.
4	Low	High	Medium	Some concern for in-situ response, but lower than HAZ-strained material	
6	Low	Medium	Medium	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
8	Low	High	Medium	Some concern for in-situ response, but lower than HAZ-strained material	

Subgroup **38.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
1,3,4,7,10,11,13,16,18,24

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	Low	Medium	Low	Performance in the field has been good. Significant dependencies of initiation and propagation not available. Evidence from INSS and other workers shows that wrought stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition.	Special surface conditions on welds such as abusive grinding, discontinuities.
4	Low	High	High	SCC initiation in SS weld metal is difficult, but growth at 517F is possible	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	Medium	Medium	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	Dilution zone with low alloy steel may cause sensitization. SCC susceptibility after low temperature aging(LTA) is not clear.	LTA and hardening can cause SCC under some certain condition. Elemental distribution in dilution zone can be critical. Profile of mixing elements is critical. And additional cyclic loading by start up and shut down.
8	Low	High	High	SCC initiation in SS weld metal is difficult, but growth at 517F is possible	Impurities and dissolved oxygen

Subgroup **38.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
2,5,8,9,12,15,17,20,21,22,23

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Dead legs close to main coolant line potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Performance in the field has been generally good except for some fatigue failures in the thermal mode. Forged materials should behave similar to the wrought materials in a general way. However, forged materials have different residual stresses and anisotropies and should not be assumed to be the same as piping materials. Also, the machining processes are not the same. The corrosion fatigue may have components of thermal effects owing to the stratification of flow that is sometimes associated with nozzles. As for wrought materials, the stainless steels may involve the corrosion fatigue adding mainly to the SCC through the stress ripple effect. However, with the thermal fatigue this will act independently. Not aware of significant information of conditions for corrosion fatigue.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Thermal fatigue a known problem and flow induced vibration conceivable	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Medium	Medium	Medium	Effects of LT aging on corrosion fatigue is not clear yet	Surface finish a known influencing factor
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **38.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
2,5,8,9,12,15,17,20,21,22,23

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	Medium	Medium	Good field experience, limited lab data, but long initiation times cannot be ignored.	Surface finish a known influencing factor
3	High	High	Medium	In general performance has been good. However, evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses. Consider mandrils and possible effect on inside surfaces
4	Low	High	Medium	SCC initiation in forged SS is difficult, but growth at 517F is possible	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	Medium	Medium	Not expected generally, but newer lab data suggests possible susceptibility in cold-worked material even in nominal water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening
8	Low	High	High	SCC initiation in forged SS is difficult, but growth at 517F is possible	Impurities and dissolved oxygen

Subgroup **38.6**

Socket welds
Type 304, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
14

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Socket welds fail in service but at a low rate. The mode of failure may be some combination of corrosion fatigue and SCC. Geometry of the socket welds makes them prone to slow cycle and high cycle fatigue owing to being a flexible member attached to a more sturdy base. Further, it is likely that the is often some moment arm on the It is the high R values that are of concern. I know nothing of how the inside surfaces are machined and to what extent such surfaces would initiate corrosion fatigue. Socket welds also sustain weld stresses and high residual stresses. Also, it is likely that they sustain abusive machining.	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	High	High	Medium	Significant field experience of failures	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **38.6**

Socket welds
Type 304, PWR primary water
517°F, 2305 psia

Applies to BNL Part #s with prefix SS-RHXCL
14

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Medium	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Surface defects possibly in welds should be considered as well as high stresses at the intersection of small lines and large lines. Residual stresses and abusive machining should be considered for corrosion fatigue and for SCC. Also, dings and dents during manufacturing and installation may produce initiation sites. Degradation here may accumulate with time owing to cyclic stressing.
4	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 517F in HAZ-strained material is possible. corrosion fatigue is dominant mode.	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	Medium	Medium	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	Medium	Medium	SCC susceptibility after low temperature aging(LTA) is not clear. Hardening can increase SCC susceptibility	LTA and hardening. Ripple stress can enhance SCC.
8	Low	High	High	SCC initiation in SS HAZ is difficult, but growth at 517F in HAZ-strained material is possible. corrosion fatigue is dominant mode.	Impurities and dissolved oxygen

Subgroup **39.1**

All stainless steel components
External surfaces at <130°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RCPINJ
1-65

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **39.1**

All stainless steel components
External surfaces at <130°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RCPINJ
1-65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **39.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
1,9,22,40,48,49 (bend),63

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **39.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
1,9,22,40,48,49 (bend),63

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Unlikely to initiate SCC for wrought piping at 130F, and growth rate is very low.	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
8	0	High	High	Unlikely to initiate SCC for wrought piping at 130F, and growth rate is very low.	Impurities and dissolved oxygen

Subgroup **39.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
1,3,5,6,7,9,10,13,15,18,19,20,22,24,26,28,30,34,36,38,40,42,43,45,47,48,49,51,53,54,57,58,59,61,63,65

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **39.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
1,3,5,6,7,9,10,13,15,18,19,20,22,24,26,28,30,34,36,38,40,42,43,45,47,48,49,51,53,54,57,58,59,61,63,65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely in HAZ than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely here than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **39.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
2,4,8,11,12,14,16,17,21,23,25,27,29,31,32,33,35,37,39,41,44,46,50,52,55,56,60,62,64

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **39.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
2,4,8,11,12,14,16,17,21,23,25,27,29,31,32,33,35,37,39,41,44,46,50,52,55,56,60,62,64

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this low temp.	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	0	High	High	Unlikely to initiate SCC for weld metal at 130F, and growth rate is very low.	Impurities and dissolved oxygen

Subgroup **39.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
3,5,7,10,13,15,18,19,20,24,26,28,30,34,36,38,42,43,45,47,51,53,54,57,58,59,61,65

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **39.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
3,5,7,10,13,15,18,19,20,24,26,28,30,34,36,38,42,43,45,47,51,53,54,57,58,59,61,65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS at 130F	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	0	High	High	Unlikely to initiate SCC for forged SS at 130F, and growth rate is very low	Impurities and dissolved oxygen

Subgroup **39.6**

Socket welds
Type 304, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
4

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Significant field experience of fatigue failures	Depends on design detail and flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	Medium	Medium	Medium	Failures in field	May be problem if high stress intensification, abrasion, cold work.
4	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
5	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
6	Medium	Medium	Medium	Significant field experience of failures at socket welds	Depends on design detail, flow induced vibration and thermal cycling
7	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
8	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration

Subgroup **39.6**

Socket welds
Type 304, PWR primary water
130°F, 2550 psia

Applies to BNL Part #s with prefix SS-RCPINJ
4

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known evidence that field cracking is due to SCC	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	Very good field experience	Surface finish a known influencing factor
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
5	0	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen
6	Low	High	High	No evidence that field failures have been due to SCC and no reason to suspect SCC susceptibility in properly managed water chemistry	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Low	High	High	Long tern issue. Anions can concentrate in the crevice region of the joint and may go up to the level, which provides SCC condition	Impurities and dissolved oxygen. SCC may happen when CF problem is mitigated. CF>SCC
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely in HAZ than elsewhere. Expect corrosion fatigue to dominate.	Impurities and dissolved oxygen

Subgroup **39.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPINJ
36.65

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	0	High	High	Even if leakage onto joint occurs, no boiling will occur to concentrate boric acid	
5	Low	High	High	Can occur only if flange leaks and leakage allowed to dry out and deposit on pipe surface	Not a significant future threat if flange leaks prevented and deposits cleaned off.
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Possible only when leak occurs	Leak
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Subgroup **39.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPINJ
36.65

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	High	Can occur only if surfaces wet or alternately wet/dry	Not considered a significant future threat.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
7	Low	High	Medium	Source of vibration stress is not clear	
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **39.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPINJ
36.65

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
5	Low	High	High	An issue only if pipe severely cold worked and exposed to a corrosive environment and/or high (cyclic) operating stresses	Not considered a significant future threat.
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen generated by corrosion may reduce fracture resistance	Hydrogen entry
8	Low	High	High	Could be problem if leaks occur	

Subgroup **39.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPINJ
36.65

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in air	
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	If moisture present GC would occur. The hydrogen produced in GC would exacerbate SCC.	Moisture
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	0	Medium	Medium	Not expected, unless comes into contact with boric acid	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **39.7**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPINJ
36.65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **40.1**

All stainless steel components
External surfaces at <250°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RCPRET
1-46

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **40.1**

All stainless steel components
External surfaces at <250°F
Containment/Auxiliary building air
Normally dry

Applies to BNL Part #s with prefix SS-RCPRET
1-46

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
6	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
7	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Insulation material is critical
8	Low	High	High	Dry environment assumed	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation

Subgroup **40.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
3 (bend),4,20,25,31,39 (bend),44

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue	Special conditions for surface effects on initiation. Residual stresses superimposed.
4	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	High	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **40.2**

Wrought austenitic stainless steel piping
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
3 (bend),4,20,25,31,39 (bend),44

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS in deoxygenated PWR primary water	Very high level of cold work needed for cracking based on over 30 years operating experience
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temperature too low unless the environment is oxygenated and contaminated.	Contamination. Surface abuse might stimulate
4	0	High	High	Unlikely to initiate SCC for wrought piping at 160-250F, and growth rate is very low.	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS at this temperature	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in wrought SS	Impurities and dissolved oxygen
8	Low	High	High	Unlikely to initiate SCC for wrought piping at 250F, and growth rate is very low.	Impurities and dissolved oxygen

Subgroup **40.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
1,3,4,6,8,10,12,14,16,18,20,22,23,25,27,29,31,33,35,36,38,39,41,43,44,46

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but HAZ effects uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	Medium	Small bore piping is more prone to vibrational fatigue. Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temperature at lower end of possible SCC. Good field experience. Would relate mostly to ripple loading	Possible vibrations
4	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **40.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
1,3,4,6,8,10,12,14,16,18,20,22,23,25,27,29,31,33,35,36,38,39,41,43,44,46

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Even if toughness is degraded, still ductile and unlikely to pose a problem	Presence of defects, accident conditions
2	0	High	Medium	not a concern at these temperatures	
5	--	Low	Low		Not enough knowledge
6	0	Medium	Medium	Not expected to be an issue at this temperature	
7	Low	Medium	Medium	SCC may tame place during start up/shut down period after LTA	Hydrogen may play some role in cracking during s-u/s-d
8	Low	High	High	In-situ response of HAZ-strained material	

Subgroup **40.3**

Austenitic weld HAZs
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
1,3,4,6,8,10,12,14,16,18,20,22,23,25,27,29,31,33,35,36,38,39,41,43,44,46

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC of HAZs after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen. Only very high levels of cold work a possible concern.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	High	Temperature at lower end of possible SCC. Good field experience	No issue here. Surface abuse might stimulate
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 130F is low -- but more likely in HAZ than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
5	Medium	High	High	Good field experience - believe some cracking has occurred presumably caused by chloride/sulfate	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination
6	Medium	High	High	Low temperature and water purity expected to preclude SCC but stresses are highest here	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	Medium	High	High	Some cracking has occurred presumably caused by chloride/sulfate	Chemical contamination such as chloride, sulfate. High residual stress required
8	Low	High	High	Unlikely to initiate SCC, and growth rate at 250F is low -- but more likely here than elsewhere	Not anticipated to be a significant generalized problem due to adventitious nature of chemical contamination

Subgroup **40.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
2,5,7,9,11,13,15,17,19,21,24,26,28,30,32,34,37,40,42,45

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials. Very good field experience so far.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue but effects on duplex weld metals uncertain. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Temp too low	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	Unlikely to initiate SCC, and growth rate at 250F is low -- but more likely here than elsewhere	Only likely to be a problem where flow induced vibration occurs during use
5	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
6	Low	Medium	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
7	Low	High	Medium	Doubt lab data base is as good as for wrought materials	Only likely to be a problem where flow induced vibration occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration occurs during use

Subgroup **40.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
2,5,7,9,11,13,15,17,19,21,24,26,28,30,32,34,37,40,42,45

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
2	0	High	Medium	not a concern at these temperatures	
3	Medium	Medium	Medium	Mills type lowering in fracture toughness	Such conditions for this lowering in fracture toughness are not well defined for stainless steels.
4	Low	High	High	In-situ response of HAZ-strained material	
5	Low	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Toughness adequate even after aging to lower limit.	Known issue. Effective prediction models.
6	0	High	High	Well characterized. Not as susceptible to thermal aging as cast austenitics due to lower ferrite and lower Cr in ferrite phase. Unlikely to have a measurable impact at this temperature.	Known issue. Effective prediction models.
7	Low	Medium	Medium	SCC may tame place during start up/shut down period after LTA	Hydrogen may play some role in cracking during s-u/s-d
8	Low	High	High	In-situ response of weld metal	

Subgroup **40.4**

Austenitic to austenitic weld metals
Type 308, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
2,5,7,9,11,13,15,17,19,21,24,26,28,30,32,34,37,40,42,45

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Very good field experience - no known cracking due to SCC after more than 30 years operating experience	Not anticipated to be a long term problem due to negligible dissolved oxygen.
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	High	Medium	Temp too low	Surface abuse might stimulate
4	Low	High	Medium	Expect no large cyclic loads	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals at this temperature in nominal primary water	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in SS weld metals	Impurities and dissolved oxygen
8	Low	High	High	Unlikely to initiate SCC for weld metal at 250F, and growth rate is very low.	Impurities and dissolved oxygen

Subgroup **40.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
1,6,8,10,12,14,16,18,22,23,27,29,33,35,36,38,41,43,46

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Assume lab data base for wrought materials applies.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High	Small bore piping is more prone to vibrational fatigue	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
5	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
6	Low	Medium	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
7	Low	High	Medium	Assume lab data base for wrought materials applies	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use
8	Low	High	Medium	Expect no large cyclic loads	Only likely to be a problem where flow induced vibration or thermal cycling occurs during use

Subgroup **40.5**

Forged austenitic stainless steel components
Types 304, 316, PWR primary water
250 to 160°F, 2185 or 95 psia

Applies to BNL Part #s with prefix SS-RCPRET
1,6,8,10,12,14,16,18,22,23,27,29,33,35,36,38,41,43,46

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS. More than 30 years of satisfactory operating experience	Very high level of cold work
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	0	High	High	Unlikely to initiate SCC for forged SS at 250F, and growth rate is very low	Impurities and dissolved oxygen
5	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
6	Low	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen, neither of which are expected in PWR primary water
7	0	High	High	No basis either from laboratory data or field experience to expect SCC initiation in forged SS	Impurities and dissolved oxygen
8	Low	High	High	Unlikely to initiate SCC for forged SS at 250F, and growth rate is very low	Impurities and dissolved oxygen

Subgroup **40.6**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPRET
1,22

Notes:

Boric Acid Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Potential issue in aerated primary water leaks	Susceptibility high if flange leaks
2	Low	High	High	Steam cutting could be an issue	
3	Low	Medium	Medium	Possible at low temperature if leaks but not clear how this occurs	Look for leaks
4	0	High	High	Even if leakage onto joint occurs, no boiling will occur to concentrate boric acid unless temp is at upper limit of 250F	
6	Medium	Medium	Medium	Known issue	Will occur if flange leak is ignored
7	Low	High	High	Only under leak condition	
8	Low	High	High	Problem could occur from boric acid and/or steam cutting from leakage	

Subgroup **40.6**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPRET
1,22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	No obvious service problems to date but CUFs not available.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	High strength will minimize the fatigue; however, the extent to which the corrosion fatigue is an integral part of the SCC, corrosion fatigue should be considered if there are low frequency cyclic stresses.	Low frequency stressing
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	High	Can occur only if surfaces wet or alternately wet/dry	Not considered a significant future threat.
6	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	
7	Low	High	Medium	Source of vibration stress is not clear	
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **40.6**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPRET
1,22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Acceptable bolt toughness is a criterion for material selection	Tempering temperature
2	0	High	Medium	Leaks could influence this degradation mode but do not consider this a problem at low temperature.	
3	Medium	Medium	Medium	The higher strength materials have lower fracture toughness as affected by high strength and possible inadequate heat treatments.	High strength and off-metallurgies.
4	0	High	High	Shouldn't be a problem if YS Tech Specs are met	
6	Low	Low	Low	Not aware of any data on reduction of FR for this material	
7	Low	High	High	Hydrogen embrittlement may reduce fracture resistance.	
8	Low	High	High	Could be problem if leaks occur	

Group **40** **Support System**

CVCS RCP Seal Return Piping 1,22 Filter

Subgroup **40.6**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPRET
1,22

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in air	
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Low	Medium	Medium	If moisture present GC would occur. The hydrogen produced in GC would exacerbate SCC.	Moisture
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	Medium	Medium	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
6	0	Medium	Medium	Not expected, unless comes into contact with boric acid	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Subgroup **40.6**

Bolted flanged joint
Flange bolts SA193 Gr B16 bolts
Building air environment

Applies to BNL Part #s with prefix SS-RCPRET
1,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Has occurred but no known major incidents since molybdenum disulfide lubricants banned	Not considered a significant future threat.
2	0	High	Medium	not a concern within one fuel cycle, can be managed by maintenance program	
3	Medium	Medium	Medium	These high strength materials are prone to SCC at low temperatures in moisture. Improper heat treatments may further exacerbate SCC. The SCC may be exacerbated by high stresses due to tightening and also be high residual stresses.	Stress ripples, tightening stresses, metallurgical errors, moisture.
4	Low	High	High	Possibility of some leakage onto bolts	
5	Low	High	Medium	Has occurred but not since Molybdenum disulfide lubricants banned	Not considered a significant future threat.
6	Low	High	Medium	Has occurred but less common since Molybdenum disulfide lubricants banned	
7	Low	High	Medium	Potential problem when contacts with water	Leak?
8	Low	High	High	Possibility of some leakage onto bolts	

Group **41** **Support System**

CCW Surge Tank Piping CCW HX
App.E.4 - All PWR Scores

Subgroup **41.1**

All outside surfaces
Low alloy steels and carbon steel, SA53, SA106, SA234, SA285
Auxiliary building air
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWHX
All except inside surfaces in HX
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Same as for pitting; corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	Well-known phenomenon. Dependent on surface condition	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Moisture and crevices
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	Theoretical concern when surface can be wet for long time	
8	Low	High	High	Assumed dry the vast majority of the time	

Group **41** **Support System**

CCW Surge Tank Piping to CCW HX
App.E.4 - All PWR Scores

Subgroup **41.1**

All outside surfaces
Low alloy steels and carbon steel,
SA53, SA106, SA234, SA285
Auxiliary building air
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWHX
All except inside surfaces in HX
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No significant effect of atmospheric corrosion expected on fatigue strength in air conditioned buildings	Temperature, relative humidity and pollutants especially chloride and sulfate
2	0	High	Medium		
3	Low	Medium	Medium	Corrosion fatigue occurs if sufficient stress and cycles present. Accelerated if stress cycle is low frequency	Cyclic stresses
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	If any possible source of cyclic stress	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **41.1**

All outside surfaces
Low alloy steels and carbon steel, SA53, SA106, SA234, SA285
Auxiliary building air
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWHX
All except inside surfaces in HX
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal rules for atmospheric corrosion in air conditioned buildings apply	Temperature, relative humidity and pollutants especially chloride and sulfate
2	Low	High	High	well known phenomenon, will depend on surface treatment and atmosphere	
3	Low	Medium	Medium	GC occurs if moisture present and accelerated if impurities present	Moisture and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **41.1**

All outside surfaces
Low alloy steels and carbon steel, SA53, SA106, SA234, SA285
Auxiliary building air
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWHX
All except inside surfaces in HX
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Can't see conditions suitable for MIC developing on pipes in air conditioned buildings	
2	0	High	Medium		
3	Low	Medium	Medium	MIC is possible at these temperatures and the microbes must produce corrosive species. Moisture required and nutrients required	Moisture and nutrients
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Specific contaminants and wetness
7	Low	High	High	Most of the time, surface should be dry	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **41.1**

All outside surfaces
Low alloy steels and carbon steel,
SA53, SA106, SA234, SA285
Auxiliary building air
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWHX
All except inside surfaces in HX
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	well-known phenomenon requires deposits and/or insulations impurities; buildup with time	
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	PIT is a potential problem when Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **41.1**

All outside surfaces
Low alloy steels and carbon steel, SA53, SA106, SA234, SA285
Auxiliary building air
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWHX
All except inside surfaces in HX
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. Accelerated by low frequency cyclic ripple.	Water or wetness. Contributions from sources of impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants (e.g. nitrates) and wetness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **41.2**

Elbows
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
2, 3, 5, 11, 12, 19, 20, 22, 22, 24, 27, 32, 33, 42, 47, 51, 61, 62, 63
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement.	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping 316/CCW HX
App.E.4 - All PWR Scores

Subgroup **41.2**

Elbows
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
2, 3, 5, 11, 12, 19, 20, 22, 22, 24, 27, 32, 33, 42, 47, 51, 61, 62, 63
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **41.2**

Elbows
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
2, 3, 5, 11, 12, 19, 20, 22, 22, 24, 27, 32, 33, 42, 47, 51, 61, 62, 63
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.2**

Elbows
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
2, 3, 5, 11, 12, 19, 20, 22, 22, 24, 27, 32, 33, 42, 47, 51, 61, 62, 63
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry; lack of flow (stagnant portion only)
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.2**

Elbows
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
2, 3, 5, 11, 12, 19, 20, 22, 22, 24, 27, 32, 33, 42, 47, 51, 61, 62, 63
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX
App.E.4 - All PWR Scores

Subgroup **41.2**

Elbows
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
2, 3, 5, 11, 12, 19, 20, 22, 22, 24, 27, 32, 33, 42, 47, 51, 61, 62, 63
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.3**

Tees, weldolets, reducers, and nozzles
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
1, 6, 7, 14, 15,16, 25, 26, 27, 28, 30,36, 37, 38, 52, 53, 54,58, 61, 69
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement.	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.3**

Tees, weldolets, reducers, and nozzles
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
1, 6, 7, 14, 15,16, 25, 26, 27, 28, 30,36, 37, 38, 52, 53, 54,58, 61, 69
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Medium	High	High	well-known phenomenon; requires cyclic stress. thermal fatigue possible near Tees	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **41.3**

Tees, weldolets, reducers, and nozzles
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
1, 6, 7, 14, 15,16, 25, 26, 27, 28, 30,36, 37, 38, 52, 53, 54,58, 61, 69
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping/CCW HX

App.E.4 - All PWR Scores

Subgroup **41.3**

Tees, weldolets, reducers, and nozzles
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
1, 6, 7, 14, 15,16, 25, 26, 27, 28, 30,36, 37, 38, 52, 53, 54,58, 61, 69

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits, but highest risk at cooler temperatures	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry; lack of flow (stagnant portion only)
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping SS-CCWHX
App.E.4 - All PWR Scores

Subgroup **41.3**

Tees, weldolets, reducers, and nozzles
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
1, 6, 7, 14, 15,16, 25, 26, 27, 28, 30,36, 37, 38, 52, 53, 54,58, 61, 69
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.3**

Tees, weldolets, reducers, and nozzles
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
1, 6, 7, 14, 15,16, 25, 26, 27, 28, 30,36, 37, 38, 52, 53, 54,58, 61, 69
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.4**

Valves
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
8, 9, 29, 34, 35, 43, 44, 45, 46, 47, 50, 54, 55,56
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Group
41

Support System

CCW Surge Tank Piping & CCW HX
App.E.4 - All PWR Scores

Subgroup
41.4

Valves
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
8, 9, 29, 34, 35, 43, 44, 45, 46, 47, 50, 54, 55,56
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress. FAC unlikely at this temperature	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **41.4**

Valves
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
8, 9, 29, 34, 35, 43, 44, 45, 46, 47, 50, 54, 55,56
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System** **CCW Surge Tank Piping & CCW HX**

Subgroup **41.4**

Valves
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
8, 9, 29, 34, 35, 43, 44, 45, 46, 47, 50, 54, 55,56
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits, but highest risk at cooler temperatures	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry; lack of flow (stagnant portion only)
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.4**

Valves
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
8, 9, 29, 34, 35, 43, 44, 45, 46, 47, 50, 54, 55,56
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping/CCW HX

App.E.4 - All PWR Scores

Subgroup **41.4**

Valves
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
8, 9, 29, 34, 35, 43, 44, 45, 46, 47, 50, 54, 55,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for valves	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping CCW HX

App.E.4 - All PWR Scores

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping/CCW HX

App.E.4 - All PWR Scores

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in normally stagnant water	
2	0	High	Medium	FAC requires flowing water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity is not well characterized	Local velocity must be evaluated.
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System** **CCW Surge Tank Piping SS-CCWHX**

App.E.4 - All PWR Scores

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Group **41** **Support System**

CCW Surge Tank Piping 316 CCW HX

App.E.4 - All PWR Scores

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System** **CCW Surge Tank Piping/CCW HX**

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits, but highest risk at cooler temperatures	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry; lack of flow (stagnant surge tank portion only)
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.5**

Straight pipe
Carbon steel and low alloy steels,
SA53, SA106, SA234, SA285
Treated water, Surge Tank portion stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
4, 13, 17, 18, 23, 31, 32, 40, 43, 49, 50, 56, 57, 59, 60, 63,64
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	0	High	High	Assume that no concentration mechanism exists. Hard to determine where stress is coming from	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for straight piping	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; crevices present	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue in normally stagnant water	
2	Low	High	High	FAC requires flowing water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	only an issue for carbon steel components that see highly turbulent flow or cavitation (pumps/valves). Unlikely here.	carbon steels, high flows/turbulence
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at flanges and hatch is not well characterized	Local velocity must be evaluated.
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System** **CCW Surge Tank Piping & CCW HX**

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Group **41** **Support System** **CCW Surge Tank Piping & CCW HX**

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits, but highest risk at cooler temperatures	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry; lack of flow (stagnant surge tank portion only)
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System** **CCW Surge Tank Piping 45 CCW HX**

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX

App.E.4 - All PWR Scores

Subgroup **41.6**

Flanges and surge tank hatch
Low alloy steels SA182, SA234, SA312, SA376
Treated water, Surge Tank portion stagnant
130°F, 150 psi, 12,000 gpm (max)

Applies to BNL Part #s with prefix SS-CCWHX
38, 39, 41, 42, 67

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Unlikely to have specific susceptibility for these components	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.7**

Surge tank comp, heads, shells
SA285, Carbon steel
Treated water, normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
65, 68

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.7**

Surge tank comp, heads, shells
SA285, Carbon steel
Treated water, normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
65, 68

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impairs
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **41.7**

Surge tank comp, heads, shells
SA285, Carbon steel
Treated water, normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
65, 68

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	0	High	Medium	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.7**

Surge tank comp, heads, shells
SA285, Carbon steel
Treated water, normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
65, 68

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant conditions in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry; lack of flow (stagnant portion only)
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.7**

Surge tank comp, heads, shells
SA285, Carbon steel
Treated water, normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
65, 68

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.7**

Surge tank comp, heads, shells
SA285, Carbon steel
Treated water, normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
65, 68

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.8**

Surge tank weld seam
SA285, Treated water
normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
66

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry
7	Low	High	High	No crevice in general and treated water with monitor	
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX

App.E.4 - All PWR Scores

Subgroup **41.8**

Surge tank weld seam
SA285, Treated water
normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
66

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Group **41** **Support System**

CCW Surge Tank Piping SS-CCWHX

App.E.4 - All PWR Scores

Subgroup **41.8**

Surge tank weld seam
SA285, Treated water
normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
66

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	0	High	Medium	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. Welds in low temperature water sometimes exhibit localized corrosion in heat affected zones. Conditions for such occurrences are not well defined.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX

App.E.4 - All PWR Scores

Subgroup **41.8**

Surge tank weld seam
SA285, Treated water
normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
66

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant conditions in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry, lack of flow
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.8**

Surge tank weld seam
SA285, Treated water
normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
66

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting can occur in stagnant lines if oxygen is present; aggravated by other corrosive impurities (sulphates, chlorides)	Stagnant lines, areas where deposits may accumulate
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.8**

Surge tank weld seam
SA285, Treated water
normally stagnant, 130°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWHX
66

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Can occur in CS piping systems but temperature too low to be a serious concern	FAC possible but unlikely in this system
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Low	Low	These velocities may be low and the cast iron should resist FAC.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	only an issue for carbon steel components that see highly turbulent flow or cavitation (pumps/valves). Unlikely here.	carbon steels, high flows/turbulence
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at casing is not well characterized	Local velocity must be evaluated.
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impairs
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Low	Low	High cycle fatigue from pump rotation and possible asymmetries. Weld defects may produce initiation sites for fatigue damage	High cycles and high stresses
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal fracture properties of cast iron, low stress and no major effect of environment anticipated	
3	Medium	Low	Low	Low fracture toughness at low temperatures and inherently brittle metallurgy	sharp corners
4	0	High	High	Not likely at this temperature	
5	Low	High	High	unlikely to be an issue at these temperatures	
6	Low	Medium	Medium	Possible potential issue	Fabrication procedures
8	Low	High	High	Not too concerned at 130F	

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	0	High	Medium	incorporated in the design	
3	Low	Low	Low	GC low since cast irons are generally corrosion resistant. General corrosion may be increased by high velocity oxygenated water.	oxygen, high velocity water
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assume low cyclic stresses	

Group **41** **Support System** **CCW Surge Tank Piping & CCW HX**

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not likely in continuously flowing water if deposits avoided	Presence of crud deposits
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Low	Medium	Low	These conditions can support MIC. Depends on water quality, nutrients, presence of oxygen	Check nutrients and oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits, but highest risk at cooler temperatures	periodic flushing of lines may leave dead legs at significant risk
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Low	Low	Pitting tendency low since no MIC due to high flow and since cast irons generally corrosion resistant.	possible pits at weld defects
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX

App.E.4 - All PWR Scores

Subgroup **41.9**

CCW Pump casing
Cast iron, Treated water
130°F, 150 psi, 4800 gpm

Applies to BNL Part #s with prefix SS-CCWHX
70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Seems unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	0	Low	Low	No evidence that this can occur	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	Potential problem if certain level of stress exist with ripple stress and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Group **41** **Support System**

CCW Surge Tank Piping & CCW HX
App.E.4 - All PWR Scores

Subgroup **41.10**

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Seems unlikely in nozzles without thermal sleeves or other crevices	Presence of crevices
2	Low	High	High	well-known phenomenon; crevices present	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Group
41

Support System

CCW Surge Tank Piping 67 / CCWHX
App.E.4 - All PWR Scores

Subgroup
41.10

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Can occur in CS piping systems but temperature too low to be a serious concern	FAC possible but unlikely in this system
2	Low	High	High	FAC unlikely at this temperature	
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible if high flows and turbulence occur; less likely at these temperatures.	areas where high flows and turbulence occur;.
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at nozzple is not well characterized	Local velocity must be evaluated.
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.10**

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field for carbon steel components	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress. Not likely here.	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **41.10**

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	0	High	Medium	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible. Unlikely here	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.10**

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not likely in continuously flowing water if deposits avoided	Presence of crud deposits
2	0	High	Medium	flow rate too high	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits, but highest risk at cooler temperatures	periodic flushing of lines may leave dead legs at significant risk
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.10**

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems with correctly treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices. Crevice corrosion would be accelerate	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits. Unlikely here.	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **41.10**

CCWHX Nozzles 30"
Carbon steel, Treated water
130°F, 150 psia, 9.98x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWHX
71,72

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible. Unlikely here.	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and bad water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.1**

All component outside surfaces
Low alloy steels and carbon steel
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRHR
1-50

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Same as for pitting; corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	Well-known phenomenon. Dependent on surface condition	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Moisture and crevices
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	Theoretical concern when surface can be wet for long time	
8	Low	High	High	Assumed dry the vast majority of the time	

Group **42** **Support System**

CCW HX Piping/RHR HX
App.E.4 - All PWR Scores

Subgroup **42.1**

All component outside surfaces
Low alloy steels and carbon steel
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRHR
1-50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No significant effect of atmospheric corrosion expected on fatigue strength in air conditioned buildings	Temperature, relative humidity and pollutants especially chloride and sulfate
2	0	High	Medium		
3	Low	Medium	Medium	Corrosion fatigue occurs if sufficient stress and cycles present. Accelerated if stress cycle is low frequency	Cyclic stresses
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	If any possible source of cyclic stress	
8	Low	High	High	Assumed dry the vast majority of the time	

Group **42** **Support System**

CCW HX Piping/RHR HX
App.E.4 - All PWR Scores

Subgroup **42.1**

All component outside surfaces
Low alloy steels and carbon steel
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRHR
1-50

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal rules for atmospheric corrosion in air conditioned buildings apply	Temperature, relative humidity and pollutants especially chloride and sulfate
2	Low	High	High	well known phenomenon, will depend on surface treatment and atmosphere	
3	Low	Medium	Medium	GC occurs if moisture present and accelerated if impurities present	Moisture and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **42.1**

All component outside surfaces
Low alloy steels and carbon steel
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRHR
1-50

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Can't see conditions suitable for MIC developing on pipes in air conditioned buildings	
2	0	High	Medium		
3	Low	Medium	Medium	MIC is possible at these temperatures and the microbes must produce corrosive species. Moisture required and nutrients required	Moisture and nutrients
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Specific contaminants and wetness
7	Low	High	High	Most of the time, surface should be dry	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **42.1**

All component outside surfaces
Low alloy steels and carbon steel
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRHR
1-50

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	well-known phenomenon requires deposits and/or insulations impurities; buildup with time	
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	PIT is a potential problem when Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **42.1**

All component outside surfaces
Low alloy steels and carbon steel
130°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRHR
1-50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. Accelerated by low frequency cyclic ripple.	Water or wetness. Contributions from sources of impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants (e.g. nitrates) and wetness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at elbow is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC rather unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 2, 3, 11, 12, 13, 15, 16, 18, 19, 23, 24, 27, 29, 34, 40, 41, 44, 45

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Group **42** **Support System**

CCW HX Piping/RHR HX
App.E.4 - All PWR Scores

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at these locations are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Medium	High	High	well-known phenomenon; requires cyclic stress. thermal fatigue possible near Tees	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
1, 3, 4, 5, 9, 10, 11, 20, 29, 31, 35, 36, 37, 38, 42, 43, 50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at valves are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress. FAC unlikely at this temperature	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
7, 8, 9, 17, 18, 21, 27, 28, 33, 47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for valves	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Low	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%; unlikely in straight pipe unless dissolved iron concentration very low	needs periodic inspection to check for any susceptible areas
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at pipe is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
5, 6, 7, 12, 14, 15, 20, 22, 23, 25, 26, 35, 37, 38, 39, 40, 42, 44, 46, 48, 50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	0	High	High	Assume that no concentration mechanism exists. Hard to know where stress is coming from.	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for straight piping	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; crevices present	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at these locations are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	Assume low cyclic stresses	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **42** **Support System**

CCW HX Piping/RHR HX
App.E.4 - All PWR Scores

Subgroup **42.6**

Flanges, Lugs on 12, 16, 18" pipe
Carbon steel (lug) Low alloy steels,
SA105, SA106, SA234, SA403
Treated water. 130°F, 150 psi, 3x10*6 lb/hr

Applies to BNL Part #s with prefix SS-CCWRHR
25, 31, 32, 48, 49
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses due to welding.
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for these components	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.1**

All component outside surfaces
Low alloy steels and carbon steel
Auxiliary building air
105°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWLDS
1-56
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Same as for pitting; corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	Well-known phenomenon. Dependent on surface condition	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Moisture and crevices
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	Theoretical concern when surface can be wet for long time	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **43.1**

All component outside surfaces
Low alloy steels and carbon steel
Auxiliary building air
105°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWLDS
1-56
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No significant effect of atmospheric corrosion expected on fatigue strength in air conditioned buildings	Temperature, relative humidity and pollutants especially chloride and sulfate
2	0	High	Medium		
3	Low	Medium	Medium	Corrosion fatigue occurs if sufficient stress and cycles present. Accelerated if stress cycle is low frequency	Cyclic stresses
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	If any possible source of cyclic stress	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **43.1**

All component outside surfaces
Low alloy steels and carbon steel
Auxiliary building air
105°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWLDS
1-56
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal rules for atmospheric corrosion in air conditioned buildings apply	Temperature, relative humidity and pollutants especially chloride and sulfate
2	Low	High	High	well known phenomenon, will depend on surface treatment and atmosphere	
3	Low	Medium	Medium	GC occurs if moisture present and accelerated if impurities present	Moisture and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **43.1**

All component outside surfaces
Low alloy steels and carbon steel
Auxiliary building air
105°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWLDS
1-56
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Can't see conditions suitable for MIC developing on pipes in air conditioned buildings	
2	0	High	Medium		
3	Low	Medium	Medium	MIC is possible at these temperatures and the microbes must produce corrosive species. Moisture required and nutrients required	Moisture and nutrients
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Specific contaminants and wetness
7	Low	High	High	Assume treated water monitored	Only under wet condition
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **43.1**

All component outside surfaces
Low alloy steels and carbon steel
Auxiliary building air
105°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWLDS
1-56
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	well-known phenomenon requires deposits and/or insulations impurities; buildup with time	
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	PIT is a potential problem when Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **43.1**

All component outside surfaces
Low alloy steels and carbon steel
Auxiliary building air
105°F and 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWLDS
1-56
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. Accelerated by low frequency cyclic ripple.	Water or wetness. Contributions from sources of impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants (e.g. nitrates) and wetness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion. Oxygen accelera	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at elbows are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **43** **Support System** **CCW Piping to Other Loads Outside Containment**

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.2**

Elbows
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
1,2, 7, 8, 14, 15, 16, 17, 20, 21, 22, 35, 36, 41, 43, 50, 51, 52

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at tees etc are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Medium	High	High	well-known phenomenon; requires cyclic stress. thermal fatigue possible near Tees	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.3**

Tees, weldolets, reducers, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
5, 6, 9, 10,18, 19 20, 21, 22, 23, 32, 38,40, 53, 55, 56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at valves are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress. FAC unlikely at this temperature	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
12, 13, 14, 29, 30, 45, 46

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for valves	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	FAC unlikely at this temperature	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at pipe is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
3, 4, 6, 7, 9, 11, 18, 23, 27, 32, 33, 34, 35, 40, 49, 53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	0	High	High	Assume that no concentration mechanism exists. Hard to know where stress is coming from.	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for straight piping	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; crevices present	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at flange et are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	Assume low cyclic stresses	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.6**

Flanges, Lugs
Carbon steel (lug) Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 200,000lb/hr

Applies to BNL Part #s with prefix SS-CCWLDS
27, 28, 37, 38, 46, 48, 49
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses due to welding.
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for these components	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Group **43** **Support System**

CCW Piping to Other Loads Outside Containment

Subgroup **43.7**

Sockolets, plugs on 1" pipe
Low alloy steels, SA105, SA106
Treated water, normally stagnant. 105°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWLDS
23, 24, 25, 26

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Crevices present, oxygen
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.7**

Sockolets, plugs on 1" pipe
Low alloy steels, SA105, SA106
Treated water, normally stagnant. 105°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWLDS
23, 24, 25, 26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue resistance shouldn't be degraded by properly treated deoxygenated water at low temperature	Flow induced vibration, presence of oxygen, impurities
2	Medium	High	Medium	small bore more prone to vibrational fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	Assume low cyclic stresses	
5	Medium	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Medium	High	Medium	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **43.7**

Sockolets, plugs on 1" pipe
Low alloy steels, SA105, SA106
Treated water, normally stagnant. 105°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWLDS
23, 24, 25, 26

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	GC can be expected in the stagnant oxygenated water depending on the water treatment.	Oxygen present, impurities accumulate
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Group **43** **Support System** **CCW Piping to Other Loads Outside Containment**

Subgroup **43.7**

Sockolets, plugs on 1" pipe
Low alloy steels, SA105, SA106
Treated water, normally stagnant. 105°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWLDS
23, 24, 25, 26

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	MIC can occur in stagnant lines in absence of oxygen and presence of nutrients and sulphate	Stagnant lines, areas where deposits may accumulate
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Medium	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain and absence of flow not helpful	Off-chemistry, absence of flow
7	Low	High	Medium	Potential problem in stagnant condition	Water condition
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.7**

Sockolets, plugs on 1" pipe
Low alloy steels, SA105, SA106
Treated water, normally stagnant. 105°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWLDS
23, 24, 25, 26

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown.	Occur especially with oxygen
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **43.7**

Sockolets, plugs on 1" pipe
Low alloy steels, SA105, SA106
Treated water, normally stagnant. 105°F, 150 psi

Applies to BNL Part #s with prefix SS-CCWLDS
23, 24, 25, 26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for these components	High residual and/or system stresses and poor water chemistry control
7	Medium	High	Medium	Field experience of leak by SCC. Problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.1**

All component outside surfaces
Low alloy steels and carbon steel
Containment/Auxiliary building air
Treated water, 105°F, 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRCP
1-58
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Same as for pitting; corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	Well-known phenomenon. Dependent on surface condition	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Moisture and crevices
4	0	High	High	Assumed to be dry in covered Aux bldg and Containment	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	Theoretical concern when surface can be wet for long time	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **44.1**

All component outside surfaces
Low alloy steels and carbon steel
Containment/Auxiliary building air
Treated water, 105°F, 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRCP
1-58
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No significant effect of atmospheric corrosion expected on fatigue strength in air conditioned buildings	Temperature, relative humidity and pollutants especially chloride and sulfate
2	0	High	Medium		
3	Low	Medium	Medium	Corrosion fatigue occurs if sufficient stress and cycles present. Accelerated if stress cycle is low frequency	Cyclic stresses
4	0	High	High	Assumed to be dry in covered Aux bldg and Containment	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	If any possible source of cyclic stress	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **44.1**

All component outside surfaces
Low alloy steels and carbon steel
Containment/Auxiliary building air
Treated water, 105°F, 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRCP
1-58
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal rules for atmospheric corrosion in air conditioned buildings apply	Temperature, relative humidity and pollutants especially chloride and sulfate
2	Low	High	High	well known phenomenon, will depend on surface treatment and atmosphere	
3	Low	Medium	Medium	GC occurs if moisture present and accelerated if impurities present	Moisture and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg and Containment	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **44.1**

All component outside surfaces
Low alloy steels and carbon steel
Containment/Auxiliary building air
Treated water, 105°F, 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRCP
1-58
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Can't see conditions suitable for MIC developing on pipes in air conditioned buildings	
2	0	High	Medium		
3	Low	Medium	Medium	MIC is possible at these temperatures and the microbes must produce corrosive species. Moisture required and nutrients required	Moisture and nutrients
4	0	High	High	Assumed to be dry in covered Aux bldg and Containment	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Specific contaminants and wetness
7	Low	High	High	Assume treated water monitored	Only under wet condition
8	Low	High	High	Assumed dry the vast majority of the time	

Group **44** **Support System**

CCW Piping to RCPs Inside Containment

Subgroup **44.1**

All component outside surfaces
Low alloy steels and carbon steel
Containment/Auxiliary building air
Treated water, 105°F, 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRCP
1-58
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Corrosive impurities from buildup of deposits	Deposits must be wet some of the time
2	Low	High	High	well-known phenomenon requires deposits and/or insulations impurities; buildup with time	
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	0	High	High	Assumed to be dry in covered Aux bldg and Containment	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Contaminants and wetness
7	Low	High	High	PIT is a potential problem when Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **44.1**

All component outside surfaces
Low alloy steels and carbon steel
Containment/Auxiliary building air
Treated water, 105°F, 150 psi (inside condition)

Applies to BNL Part #s with prefix SS-CCWRCP
1-58
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. Accelerated by low frequency cyclic ripple.	Water or wetness. Contributions from sources of impurities
4	0	High	High	Assumed to be dry in covered Aux bldg	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary or containment building	Residual stresses plus specific contaminants (e.g. nitrates) and wetness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity. Oxygen accelerates.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	0	High	Medium	flow rate and temperature too low	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at elbow is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	0	High	Medium	unlikely for this component: assumes no stagnant regions	
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.2**

Elbows
Low alloy steels, SA105, SA106, SA234
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
5, 6, 7, 11, 12, 13, 32, 33, 34, 39, 40

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	0	High	Medium	flow rate and temperature too low	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at tees etc.are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Medium	High	High	well-known phenomenon; requires cyclic stress. thermal fatigue possible near Tees	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.3**

Tees, weldolets, reducers, threaded caps, and nozzles
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
15, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 30, 31, 32, 41, 42, 43, 44, 45

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Medium	High	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds & when operated at 130F and above	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	0	High	Medium	flow rate and temperature too low	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at elbow is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress. FAC unlikely at this temperature	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.4**

Valves
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
1, 2, 4, 5, 9, 10, 11, 21, 22, 37, 51, 52, 53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for valves	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; very likely in vicinity of welds with overhang	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	0	High	Medium	flow rate and temperature too low	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at pipe is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	No cyclic loads assumed	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.5**

Straight pipe
Low alloy steels, SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
2, 3, 7, 8,9, 13, 14, 15, 16, 22, 23, 27, 28, 29, 30, 34, 35. 36, 38, 40, 41, 45, 46, 47, 49, 51, 54, 55

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	0	High	High	Assume that no concentration mechanism exists. Hard to know where stress is coming from.	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for straight piping	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	Low	High	High	well-known phenomenon; crevices present	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	0	High	Medium	flow rate and temperature too low	
3	Low	Medium	Low	Depends on pH, flow, oxygen	Should check conditions relative to FAC
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Medium	High	High	Possible under very high flow and/or turbulence conditions; particular concern if Cr content < 0.03 wt.%	needs good inspection program
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry, turbulent flow
7	Low	High	Medium	Flow pattern and local velocity at flange and lugs are not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	Assume low cyclic stresses	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	will occur if stagnant or near stagnant water, but with properly treated water should not be a problem	
3	Low	Medium	Low	Doubt that MIC would occur at these velocities but this can occur.	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water	unlikely to be a life-limiting concern.
6	0	High	High	Unlikely given the flow rate	
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	Low	High	High	Pitting can occur in stagnant lines if oxygen and other corrosive impurities (sulphates, chlorides) present	stagnant lines, areas where deposits may accumulate
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.6**

Flanges, Lugs
Carbon steel (lug), Low alloy steels
SA105, SA106, SA234, SA403
Treated water, 105°F, 150 psi, 40-700 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
47, 48, 56, 57
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses due to welding.
4	Low	High	High	Assume that no concentration mechanism exists	SCC in these systems very dependent on creation of concentrated environment
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for these components	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.7**

Flexible 2" hose
Low alloy steels, SA105, carbon steel
Treated water, 105°F, 2485 psi, 40 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
58

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	0	High	Medium	component not relevant	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	0	High	High	No crevice in general	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.7**

Flexible 2" hose
Low alloy steels, SA105, carbon steel
Treated water, 105°F, 2485 psi, 40 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
58

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	0	High	Medium	component not relevant	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work. Also, this application may include low cycle fatigue that would be especially aggressive.
4	Low	High	High	Assume low cyclic stresses	
5	Medium	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assume low cyclic stresses	

Subgroup **44.7**

Flexible 2" hose
Low alloy steels, SA105, carbon steel
Treated water, 105°F, 2485 psi, 40 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
58

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	0	High	Medium	component not relevant	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. Virtually stagnant and oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.7**

Flexible 2" hose
Low alloy steels, SA105, carbon steel
Treated water, 105°F, 2485 psi, 40 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
58

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	component not relevant	
3	Medium	Medium	Medium	At lower velocities, MIC may occur depending on the availability of nutrients.	nutrients, complex geometries.
4	Low	High	High	Assuming water treatment is properly maintained	
5	Medium	High	High	Needs low flows (dead flow areas), crevices or deposits and impurities, especially sulphate and bacteria. Unlikely in treated water, but can occur if lines periodically exposed to untreated chemistries/air.	Likely to require some replacements but can be managed; unlikely to be a life-limiting concern.
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry; low flow rate
7	Low	High	High	Assume treated water monitored	
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.7**

Flexible 2" hose
Low alloy steels, SA105, carbon steel
Treated water, 105°F, 2485 psi, 40 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
58

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting not likely in flowing systems with deoxygenated treated water	Oxygen, impurities
2	0	High	Medium	component not relevant	
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **44.7**

Flexible 2" hose
Low alloy steels, SA105, carbon steel
Treated water, 105°F, 2485 psi, 40 gpm

Applies to BNL Part #s with prefix SS-CCWRCP
58

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	0	High	Medium	component not relevant	
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in water environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses, ripply loading. Complex geometries.
4	Low	High	High	Assuming water treatment is properly maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Less likely to have specific susceptibility for these components	High residual and/or system stresses and poor water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water treatment is properly maintained	

Subgroup **45.1**

All component outside surfaces
Stainless steel or TP 304
Fuel handling building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
1-66

Notes: except buried in concrete

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time but hard to imagine crevices filling with electrolyte	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	0	High	Medium		
4	0	High	High	Assumed to be dry in covered Fuel handling bldg.	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in fuel handling building	Contaminants and wetness
7	Low	Medium	Medium	Sleeve/container concrete interface is a potential problem for LAS and CS associate with concrete neutralization	Rebar corrosion is well known but mostly outside building which can be wet by rain etc.
8	Low	High	High	Assumed dry the vast majority of the time	

Group **45** **Support System** **Spent Fuel Pool Cooling Piping**

Subgroup **45.1**

All component outside surfaces
Stainless steel or TP 304
Fuel handling building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
1-66

Notes: except buried in concrete

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue issues dealt with in other sub-groups of Group 45. No environmental enhancement expected in a controlled air environment	
2	0	High	Medium		
4	0	High	High	Assumed to be dry in covered Fuel handling bldg.	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	0	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
7	0	High	High	No significant cyclic stress	
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.1**

All component outside surfaces
Stainless steel or TP 304
Fuel handling building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
1-66
Notes: except buried in concrete

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Atmospheric general corrosion in controlled air environment buildings not an issue	
2	0	High	Medium		
4	0	High	High	Assumed to be dry in covered Fuel handling bldg.	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	0	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in fuel handling building	Contaminants and wetness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.1**

All component outside surfaces
Stainless steel or TP 304
Fuel handling building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
1-66
Notes: except buried in concrete

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Hard to imagine how the conditions necessary for MIC can occur without the components being submerged or buried	
2	0	High	Medium		
4	0	High	High	Assumed to be dry in covered Fuel handling bldg.	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	0	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in fuel handling building	Specific contaminants and wetness
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.1**

All component outside surfaces
Stainless steel or TP 304
Fuel handling building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
1-66
Notes: except buried in concrete

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	High	High	Unlikely that sufficient contamination and moisture would occur in fuel handling building	Contaminants and wetness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped. (2)Straip current exist between sleeves and concrete.	Any possibility of water moisture condensation and strap current due to insulator degradation of electrical cable through electrical penetration
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.1**

All component outside surfaces
Stainless steel or TP 304
Fuel handling building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
1-66
Notes: except buried in concrete

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	High	High	Unlikely that sufficient contamination and moisture would occur in fuel handling building	Residual stresses plus specific contaminants (e.g. chlorides) and wetness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.2**

Outside surfaces embedded in concrete
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
56
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Stainless steel performance in concrete is excellent over many decades and greatly surpasses that of carbon steel even in difficult marine conditions. Not an issue	
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	If the SS is coated some cells might develop depending on the concrete, its carbonation, impurities	Diffusion of oxygen, CO2, presence of impurities
4	Low	High	High	Assumed to be dry	
5	Low	High	High	likely only if concrete wet and contaminated with chlorides or other corrosive anions	moisture and corrosive impurities that overwhelm alkalinity of concrete
6	Low	Medium	Medium	Concrete should protect here	Integrity of concrete
7	Low	Medium	Medium	Only when the interface of TP 304 pipe and concrete becomes wet and concrete neutralization takes place.	Normally dry
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.2**

Outside surfaces embedded in concrete
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
56
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Concrete alkalinity completely inimical to MIC	
2	Medium	High	High	Well known phenomenon, will occur under stagnant conditions	
3	Low	Medium	Medium	The presence of microbes at the interface depends on the quality of construction, the use of biocides, presence of organics and other nutrients, diffusion of water	microbes, water, nutrients
4	Low	High	High	Assumed to be dry	
5	Low	High	High	likely only if concrete wet and contaminated with bacteria and/ or corrosive anions	moisture and bacterial and/or corrosive impurities that overwhelm alkalinity (protectiveness) of concrete
6	Low	Medium	Medium	Concrete should protect here	Integrity of concrete
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.2**

Outside surfaces embedded in concrete
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLG
56
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Stainless steel performance in concrete is excellent over many decades and greatly surpasses that of carbon steel even in difficult marine conditions. Not an issue	
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	The possibility of pitting depends on the presence of MIC, impurities in the concrete, water/cement ratio, diffusion of oxygen	oxygen, water, impurities
4	Low	High	High	Assumed to be dry	
5	Low	High	High	likely only if concrete wet and contaminated with chlorides or other corrosive anions	moisture and corrosive impurities that overwhelm alkalinity of concrete
6	Low	Medium	Medium	Concrete should protect here	Integrity of concrete
7	Low	Medium	Medium	Only when the interface of TP 304 pipe and concrete becomes wet and concrete neutralization takes place.	Normally dry
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **45.3**

Elbows
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
2, 4, 13, 18, 19, 20, 26, 27, 28, 31, 34, 36, 37, 38, 39, 42, 43, 53, 54, 55
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion a credible threat for this grade of stainless steel in aerated, acidic water although unlikely in elbows	Crevice geometry with restricted flow
2	0	High	Medium	should not be crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	Possible if crevices or deposits and/or impurities present; unlikely here	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.3**

Elbows
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
2, 4, 13, 18, 19, 20, 26, 27, 28, 31, 34, 36, 37, 38, 39, 42, 43, 53, 54, 55
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs	Flow induced vibration
2	0	High	Medium	no cyclic loading mode	
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Low	High	High	Requires high cyclic stresses; more likely if elbows are severely cold worked	
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **45.3**

Elbows
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
2, 4, 13, 18, 19, 20, 26, 27, 28, 31, 34, 36, 37, 38, 39, 42, 43, 53, 54, 55
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant and low flow rate conditions	
3	0	High	Medium	MIC not possible at these flows	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities, including bacteria	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.3**

Elbows
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
2, 4, 13, 18, 19, 20, 26, 27, 28, 31, 34, 36, 37, 38, 39, 42, 43, 53, 54, 55
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.3**

Elbows
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
2, 4, 13, 18, 19, 20, 26, 27, 28, 31, 34, 36, 37, 38, 39, 42, 43, 53, 54, 55
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work)	
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.4**

Tees, weldolets, reducers, threaded caps, and nozzles
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 16, 18, 23, 24, 25, 35, 36, 44, 45, 46, 47, 48, 49
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for this grade of stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	Possible if crevices or deposits and/or impurities present; unlikely here	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.4**

Tees, weldolets, reducers, threaded caps, and nozzles
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 16, 18, 23, 24, 25, 35, 36, 44, 45, 46, 47, 48, 49
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs	Flow induced vibration
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Medium	High	High	Requires high cyclic stresses; weldolets may be more susceptible	potential issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming fatigue loads are limited	

Group **45** **Support System** **Spent Fuel Pool Cooling Piping**

Subgroup **45.4**

Tees, weldolets, reducers, threaded caps, and nozzles
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 16, 18, 23, 24, 25, 35, 36, 44, 45, 46, 47, 48, 49

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant and low flow rate conditions	
3	0	High	Medium	MIC not possible at these flows	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities, including bacteria	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.4**

Tees, weldolets, reducers, threaded caps, and nozzles
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 16, 18, 23, 24, 25, 35, 36, 44, 45, 46, 47, 48, 49

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting not likely to be significant	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.4**

Tees, weldolets, reducers, threaded caps, and nozzles
Stainless steel or TP 304
Borated water, oxygenated
70-110°F and 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 16, 18, 23, 24, 25, 35, 36, 44, 45, 46, 47, 48, 49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work, threads, etc.)	potential issue
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Group **45** **Support System** **Spent Fuel Pool Cooling Piping**

Subgroup **45.5**

Valves on 10, 12, 14, 16, 18" pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
11, 12, 13, 28, 29, 30, 31, 33, 34, 41, 51

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for this grade of stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	Possible if crevices or deposits and/or impurities present; unlikely here	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.5**

Valves on 10, 12, 14, 16, 18" pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
11, 12, 13, 28, 29, 30, 31, 33, 34, 41, 51

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs	Flow induced vibration
2	0	High	Medium	should be incorporated in the valve design	
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Low	High	High	Requires high cyclic stresses; more likely if elbows are severely cold worked	
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **45.5**

Valves on 10, 12, 14, 16, 18" pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
11, 12, 13, 28, 29, 30, 31, 33, 34, 41, 51

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant and low flow rate conditions	
3	0	High	Medium	MIC not possible at these flows	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities, including bacteria	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.5**

Valves on 10, 12, 14, 16, 18" pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
11, 12, 13, 28, 29, 30, 31, 33, 34, 41, 51

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting not likely to be significant	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.5**

Valves on 10, 12, 14, 16, 18" pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
11, 12, 13, 28, 29, 30, 31, 33, 34, 41, 51

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work)	
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.6**

Straight pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 2, 3, 11, 14, 25, 26, 30, 32, 33, 44, 48, 52, 53, 56
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for this grade of stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	0	High	Medium	should not be crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	Possible if crevices or deposits and/or impurities present; unlikely here	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.6**

Straight pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 2, 3, 11, 14, 25, 26, 30, 32, 33, 44, 48, 52, 53, 56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs	Flow induced vibration
2	0	High	Medium	no cyclic loading mode	
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Low	High	High	Requires high cyclic stresses; more likely if elbows are severely cold worked	
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **45.6**

Straight pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 2, 3, 11, 14, 25, 26, 30, 32, 33, 44, 48, 52, 53, 56
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant and low flow rate conditions	
3	0	High	Medium	MIC not possible at these flows	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities, including bacteria	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.6**

Straight pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 2, 3, 11, 14, 25, 26, 30, 32, 33, 44, 48, 52, 53, 56

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting not likely to be significant	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.6**

Straight pipe
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
1, 2, 3, 11, 14, 25, 26, 30, 32, 33, 44, 48, 52, 53, 56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work. Residual stresses in the straight pipe may be less than cold formed components such as elbows	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work)	
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Group **45** **Support System** **Spent Fuel Pool Cooling Piping**

Subgroup **45.7**

Flanges, Lugs
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
14, 21, 22, 23, 32, 39, 40, 49, 50

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for this grade of stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if crevices or deposits and/or impurities present; unlikely here	potential issue
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.7**

Flanges, Lugs
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
14, 21, 22, 23, 32, 39, 40, 49, 50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs	Flow induced vibration
2	0	High	Medium	no cyclic loading mode	
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Medium	High	High	Requires high cyclic stresses; weldolets may be more susceptible	potential issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **45.7**

Flanges, Lugs
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
14, 21, 22, 23, 32, 39, 40, 49, 50

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant and low flow rate conditions	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities, including bacteria	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.7**

Flanges, Lugs
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
14, 21, 22, 23, 32, 39, 40, 49, 50

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Pits occur if oxygen present and flow; not extensive. May interact with corrosion fatigue and SCC.	Oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.7**

Flanges, Lugs
Stainless steel or TP 304
Borated water, oxygenated
70-110°F, 65 psi, 4350 lb/hr

Applies to BNL Part #s with prefix SS-SFPCLG
14, 21, 22, 23, 32, 39, 40, 49, 50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	SCC is accelerated with oxygen and flow in crevice geometry. Also, geometry of the flange may produce special intensitifations of stress in addition to welds or cold work.	Oxygen, cold work, impurities
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work, threads, etc.)	potential issue
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.8**

Weldolet, pipe, caps
Stainless steel or TP 304
Stagnant, capped line
Borated water, oxygenated, 70-110°F and 65 psi.

Applies to BNL Part #s with prefix SS-SFPCLG
5, 6, 7, 8, 9, 10
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for this grade of stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if crevices or deposits and/or impurities present;	possible here
6	Medium	Medium	Medium	Possible (since stagnant) if contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.8**

Weldolet, pipe, caps
Stainless steel or TP 304
Stagnant, capped line
Borated water, oxygenated, 70-110°F and 65 psi.

Applies to BNL Part #s with prefix SS-SFPCLG
5, 6, 7, 8, 9, 10
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not likely to be an issue in a stagnant line	
2	Medium	High	Medium	Significant field experience of failures	Depends on design detail and flow induced vibration
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Medium	High	High	Requires high cyclic stresses; weldolets may be more susceptible	potential issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	0	High	High	Temperarture is low enough not causing FR	
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **45.8**

Weldolet, pipe, caps
Stainless steel or TP 304
Stagnant, capped line
Borated water, oxygenated, 70-110°F and 65 psi.

Applies to BNL Part #s with prefix SS-SFPCLG
5, 6, 7, 8, 9, 10
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	
3	Medium	High	High	MIC likely in stagnant line if nutrients and oxygen present	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Medium	High	High	likely if water contaminated with corrosive impurities, including bacteria	possible here
6	Medium	Medium	Medium	Possible (since stagnant) if contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.8**

Weldolet, pipe, caps
Stainless steel or TP 304
Stagnant, capped line
Borated water, oxygenated, 70-110°F and 65 psi.

Applies to BNL Part #s with prefix SS-SFPCLG
5, 6, 7, 8, 9, 10

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting not likely to be significant	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Medium	Medium	Medium	Possible (since stagnant) if contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.8**

Weldolet, pipe, caps
Stainless steel or TP 304
Stagnant, capped line
Borated water, oxygenated, 70-110°F and 65 psi.

Applies to BNL Part #s with prefix SS-SFPCLG
5, 6, 7, 8, 9, 10

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work, threads, etc.)	potential issue
6	Medium	High	High	Possible (since stagnant) if contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.9**

SFP HX tubesheet nozzles, tubesheet, tubes,
Stainless steel
Borated water, oxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
57, 58, 59

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for most austenitic stainless steels in aerated, acidic water	Crevices created by crud deposits
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	Possible if crevices or deposits and/or impurities present; unlikely here	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.9**

SFP HX tubesheet nozzles, tubesheet, tubes,
Stainless steel
Borated water, oxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
57, 58, 59

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field.	Deoxygenated water and surface finish effects on corrosion fatigue of austenitic materials a known issue. Any thermal mixing zones potentially vulnerable to thermal fatigue
2	Medium	High	High		
3	0	High	High	No fatigue here	
5	Low	High	High	risk (to tubes) only if tubes can vibrate	vibration of tubes
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.9**

SFP HX tubesheet nozzles, tubesheet, tubes,
Stainless steel
Borated water, oxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
57, 58, 59

Notes:

Galvanic Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	I find it difficult to believe that anybody could be so negligent as to leave galvanic couples in aerated acidic solutions	
2	--	--	--	insufficient information about material combinations to assess	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible where tube-to-tubesheet joints occur; needs oxygenated external (to crevice) environment, plus corrosive impurities.	tube-to-tubesheet crevice
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.9**

SFP HX tubesheet nozzles, tubesheet, tubes,
Stainless steel
Borated water, oxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
57, 58, 59

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	
3	Low	High	High	MIC less likely in stagnant line if nutrients and oxygen present	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible where tube-to-tubesheet joints occur; needs bacteria-contaminated environment, plus corrosive impurities.	tube-to-tubesheet crevice
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.9**

SFP HX tubesheet nozzles, tubesheet, tubes,
Stainless steel
Borated water, oxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
57, 58, 59

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Pitting accelerated by oxygen and impurities.	Oxygen and impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible where tube-to-tubesheet joints occur; needs oxygenated environment, plus corrosive impurities.	tube-to-tubesheet crevice
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.9**

SFP HX tubesheet nozzles, tubesheet, tubes,
Stainless steel
Borated water, oxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
57, 58, 59

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	SCC is accelerated by oxygen and by presence of pits. Impurities important.	Oxygen, impurities, pits
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work)	
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.10**

SFP pump and associated: pump casing, strainer, strainer screen, strainer supports, strainer bottom ring
Stainless steel
Borated water, oxygenated, 70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
62, 63, 64, 65, 66

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	Medium	Medium	Presence of crevices together with oxygen produces corrosive condition inside the crevices	Oxygen, crevice geometries
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible where tube-to-tubesheet joints occur; needs oxygenated external (to crevice) environment, plus corrosive impurities.	tube-to-tubesheet crevice
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.10**

SFP pump and associated: pump casing, strainer, strainer screen, strainer supports, strainer bottom ring
Stainless steel
Borated water, oxygenated, 70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
62, 63, 64, 65, 66

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs	Flow induced vibration
2	Low	High	High	strainer components could be affected	
4	Low	High	High	Assuming fatigue loads are limited	
5	Low	High	High	Requires high cyclic stresses; more likely if material severely cold worked	
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a possible cause when become large but normaly small	
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **45.10**

SFP pump and associated: pump casing, strainer, strainer screen, strainer supports, strainer bottom ring
Stainless steel
Borated water, oxygenated, 70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
62, 63, 64, 65, 66

Notes:

Galvanic Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	I find it difficult to believe that anybody could be so negligent as to leave galvanic couples in aerated acidic solutions	
2	--	--	--	insufficient information about material combinations to assess	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely in all-stainless system; possible if SS to carbon steel joints exist	SS to carbon steel joints
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.10**

SFP pump and associated: pump casing, strainer, strainer screen, strainer supports, strainer bottom ring
Stainless steel
Borated water, oxygenated, 70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
62, 63, 64, 65, 66

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible where tube-to-tubesheet joints occur; needs bacteria-contaminated environment, plus corrosive impurities.	tube-to-tubesheet crevice
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.10**

SFP pump and associated: pump casing, strainer, strainer screen, strainer supports, strainer bottom ring
Stainless steel
Borated water, oxygenated, 70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
62, 63, 64, 65, 66

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries with presence of oxygen and possible impurities and possible galvanic geometries will produce pits	Oxygen, crevice geometries
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	possible where tube-to-tubesheet joints occur; needs oxygenated environment, plus corrosive impurities.	tube-to-tubesheet crevice
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.10**

SFP pump and associated: pump casing, strainer, strainer screen, strainer supports, strainer bottom ring
Stainless steel
Borated water, oxygenated, 70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
62, 63, 64, 65, 66

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	SCC may be produced by high residual stresses, complex geometries that increase local stresses, high oxygen, and impurities	High residual stresses, oxygen, impurities
4	Low	High	High	Assuming water quality remains good	
5	Medium	High	High	Possible if impurities and/or high stresses present (e.g. cold work)	
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Assume treated water with monitoring	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not likely in deoxygenated water	Oxygen ingress
2	Low	High	High	well-known phenomenon; crevices present	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. High velocity oxygenated flow will accelerate crevice corrosion	Crevices of mechanical or deposit origin; presence of oxygen, high water velocity. Oxygen accelerates.
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	periodic flushing of lines may leave dead legs at significant risk
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	No crevice in general	
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Temperature very low for FAC	
2	0	High	Medium	flow rate and temperature too low	
4	Medium	Medium	Medium	Depends critically on specific values of flow rate, pH, T and oxygen content. System parameters given do not allow for critical analysis	
5	Low	High	High	Likely only if high local flows and/or turbulence present; not common in cool water conditions	unlikely to be a concern, but periodic inspection recommended
6	Low	Medium	Medium	Some potential for damage	Water chemistry and flow rate
7	Low	High	Medium	Flow pattern and local velocity at nozzple is not well characterized	Local velocity must be evaluated.
8	Low	High	Medium	FAC not as likely at low temp because threshold O2 is lower, and I think there is at least ~10 ppb O2	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely to be a big effect of environment on fatigue in properly treated water	Failure of water treatment procedures leading to localized corrosion and easier initiation of fatigue cracking
2	Low	High	High	well-known phenomenon; requires cyclic stress.	high stress areas susceptible (flanges, welds, turbulent flows)
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	Assume little source of vibratory loading	
5	Low	High	High	likely under deposits if oxygen and chlorides present; can also occur at other mechanical crevice sites	deposits a concern
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal general corrosion rates expected in properly treated water	
2	Low	High	High	incorporated in the design	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC. High velocity oxygenated water accelerates GC.	Oxygen and impurities; high water velocity.
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	corrosive impurity contamination
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	High	GC is a potential problem depending upon flow velocity and water quality	Oxygen content and flow velocity
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible, along with deposits	deposits a concern
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting shouldn't occur in properly treated water	Areas where deposits may accumulate. Systems that are periodically flushed with aerated water.
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Medium	Medium	Medium	Conditions for pitting likely during shutdown. Also, high velocity oxygenated water accelerates pitting	Occur especially with oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	cyclic stress areas with high residual stress (welds, flanges)
6	Low	Medium	Medium	Low susceptibility should be guaranteed by adherence to water treatment guidelines, but some issues remain	Off-chemistry
7	Low	High	Medium	PIT is a potential problem when flow induced local cell is formed, which can happen even very high velocity if oxygen exists	Flow pattern and local velocity
8	Low	High	High	Assuming water quality remains good	

Subgroup **45.11**

SPF Shellside: shell, nozzles 18"; Lug on part 32
Carbon steel
CCW water, deoxygenated
70-110°F, 65 psi, 4350 gpm

Applies to BNL Part #s with prefix SS-SFPCLG
32, 60, 61

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known SCC mechanisms in properly treated water	
2	Low	High	High	dependent on surface condition	Will depend on contaminants and deposits, not only chlorides
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	Very unlikely at these low temp in deoxygenated water	
5	Low	High	High	a problem if significant contamination with oxygen, chlorides or other corrosive anions possible	most likely to occur in oxygenated conditions
6	Low	Medium	Medium	Water treatment issues resulting in SCC have occurred in a variety of C & LAS CCW components, particularly at welds, but temperature here is probably too low	High residual and/or system stresses and bad water chemistry control
7	Low	High	High	Potential problem if certain level of stress exist and water contamination	Stress and water chemistry
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.1**

All component outside surfaces
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLN
1-46
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Hard to see how this is credible on outside surfaces exposed to air	
2	0	High	Medium	should not be crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants and wetness
7	Low	Medium	Medium	Sleeve/container concrete interface is a potential problem for LAS and CS associate with concrete neutralization	Rebar corrosion is well known but mostly outside building which can be wet by rain etc.
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.1**

All component outside surfaces
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLN
1-46
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal fatigue properties expected - no environmental effect	
2	0	High	Medium	no cyclic loading mode from outside	
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming fatigue loads are limited	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	0	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design, piping supports, etc.
8	Low	High	High	Assuming fatigue loads are limited	

Subgroup **46.1**

All component outside surfaces
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLN
1-46
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Normal negligible air corrosion rates for stainless steel	
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	0	High	High	Not signif	
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	0	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants and wetness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.1**

All component outside surfaces
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLN
1-46
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Hard to imagine how the conditions necessary for MIC can occur without the components being submerged or buried	
2	0	High	Medium		
4	0	High	High		
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	0	Medium	Medium	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants and wetness
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **46.1**

All component outside surfaces
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLN
1-46
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	Medium	2 scoring for knowledge in PIT and SCC associated with lack of knowledge of Cl and sensitivity of damage to this value	Pitting of internally wetted components possible at contaminant concentration regions during layup. Not a problem if good practice used. Unknown effects of secondary anions
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	High	High	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants (e.g. chlorides) and wetness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped. (2)Straip current exist between sleeves and concrete.	Any possibility of water moisture condensation and strap current due to insulator degradation of electrical cable through electrical penetration
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **46.1**

All component outside surfaces
Stainless steel or TP 304
Auxiliary building air
Borated water, 70-110°F and 65 psi (inside condition)

Applies to BNL Part #s with prefix SS-SFPCLN
1-46
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	Medium	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time	Concern only if wet. Tolerance level for Cl depends on buffer availability from insulation. Concern that this will become worse in USA if CalSil is removed because of sump pump blockage issues (i.e. silicate inhibition of SCC removed c.f. RG 1.36)
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	High	High	Unlikely that sufficient contamination and moisture would occur in auxiliary building	Residual stresses plus specific contaminants (e.g. chlorides) and wetness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	Low	High	High	Assumed dry the vast majority of the time	

Subgroup **46.2**

Elbows
SS TP 304, 316
Borated water, 70-110°F, 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
7, 8,10, 11, 16, 17, 22, 30, 31, 35,

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion a credible threat for Type 304 stainless steel in aerated, acidic water although unlikely in elbows	Crevice geometry with restricted flow
2	0	High	Medium	should not be crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and deposits or other crevices present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.2**

Elbows
SS TP 304, 316
Borated water, 70-110°F, 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
7, 8,10, 11, 16, 17, 22, 30, 31, 35,

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs
2	0	High	Medium	thermal fatigue not relevant at these temperatures and vibrations at low flow rates will not result in fatigue	vibrations from pumps close to elbows will influence the loading
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	Assuming no cyclic stresses	
5	Low	High	High	likely only if water contaminated with corrosive impurities and high cyclic stresses and/or cold work present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming cyclic stresses are not too high	

Subgroup **46.2**

Elbows
SS TP 304, 316
Borated water, 70-110°F, 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
7, 8,10, 11, 16, 17, 22, 30, 31, 35,

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in flowing borated solutions.	High flow and presnece of biocide
2	0	High	High	Non-stagnent borated water is non condisive to MIC	
3	0	High	Medium	MIC not possible at these flows	
4	Low	High	High	Possible , but unlikely in borated water	
5	Low	High	High	Very unlikley; borated water typically inhibits MIC	
6	0	High	High	Not likely in a non-stagnant system	Maintenance of some reasonable flow rate
7	Low	High	High	Borated water minimizes MIC	Water treatment
8	Low	High	High	Borated water should limit most forms of MIC	

Subgroup **46.2**

Elbows
SS TP 304, 316
Borated water, 70-110°F, 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
7, 8,10, 11, 16, 17, 22, 30, 31, 35,

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	0	High	High	Not signifc without chloride	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.2**

Elbows
SS TP 304, 316
Borated water, 70-110°F, 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
7, 8,10, 11, 16, 17, 22, 30, 31, 35,

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and areas of cold work or high stress present	unlikely to be an issue, especially since MoS2 banned
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.3**

Tees, weldolets, reducers, threaded caps, and nozzles
SS TP 304/316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 12, 13, 14, 19, 20, 22, 23, 24, 25, 26, 27, 28, 32, 33, 35

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for type 304 stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and deposits or other crevices (e.g. thread roots) present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.3**

Tees, weldolets, reducers, threaded caps, and nozzles
SS TP 304/316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 12, 13, 14, 19, 20, 22, 23, 24, 25, 26, 27, 28, 32, 33, 35

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs
2	0	High	Medium	thermal fatigue not relevant at these temperatures and vibrations at low flow rates will not result in fatigue	vibrations from pumps close to elbows will influence the loading
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	Assuming no cyclic stresses	
5	Low	High	High	likely only if water contaminated with corrosive impurities and high cyclic stresses and/or cold work present	could be an issue for some of these components (e.g. weldolets); not life-limiting
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming cyclic stresses are not too high	

Subgroup **46.3**

Tees, weldolets, reducers, threaded caps, and nozzles
SS TP 304/316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 12, 13, 14, 19, 20, 22, 23, 24, 25, 26, 27, 28, 32, 33, 35

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	0	High	High	Not signifc without chloride	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.3**

Tees, weldolets, reducers, threaded caps, and nozzles
SS TP 304/316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 12, 13, 14, 19, 20, 22, 23, 24, 25, 26, 27, 28, 32, 33, 35

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and at areas of cold work or high stress such as thread roots	unlikely to be an issue, especially since MoS2 banned
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.4**

Valves
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
5,6, 14, 15, 18, 21, 34, 38

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for type 304 stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and deposits or other crevices present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.4**

Valves
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
5,6, 14, 15, 18, 21, 34, 38

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs
2	0	High	Medium	thermal fatigue not relevant at these temperatures and vibrations at low flow rates will not result in fatigue	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	Assuming no cyclic stresses	
5	Low	High	High	likely only if water contaminated with corrosive impurities and high cyclic stresses and/or cold work present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming cyclic stresses are not too high	

Subgroup **46.4**

Valves
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
5,6, 14, 15, 18, 21, 34, 38

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	0	High	High	Not signifc without chloride	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.4**

Valves
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
5,6, 14, 15, 18, 21, 34, 38

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and areas of cold work or high stress present	unlikely to be an issue
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.5**

Straight pipe
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 4, 5, 7, 9, 10, 12, 19, 20, 23, 24, 28, 29, 30, 32, 36

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion a credible threat for Type 304 stainless steel in aerated, acidic water although unlikely in straight pipes	Crevice geometry with restricted flow
2	0	High	Medium	should not be crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and deposits or other crevices present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.5**

Straight pipe
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 4, 5, 7, 9, 10, 12, 19, 20, 23, 24, 28, 29, 30, 32, 36

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs
2	0	High	Medium	thermal fatigue not relevant at these temperatures and vibrations at low flow rates will not result in fatigue	vibrations from pumps close to elbows will influence the loading
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	Assuming no cyclic stresses	
5	Low	High	High	likely only if water contaminated with corrosive impurities and high cyclic stresses and/or cold work present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming cyclic stresses are not too high	

Subgroup **46.5**

Straight pipe
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 4, 5, 7, 9, 10, 12, 19, 20, 23, 24, 28, 29, 30, 32, 36

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	0	High	High	Not signifc without chloride	
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.5**

Straight pipe
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
1, 2, 3, 4, 5, 7, 9, 10, 12, 19, 20, 23, 24, 28, 29, 30, 32, 36

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work. Residual stresses in the straight pipe may be less than cold formed components such as elbows	High residual stresses
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and areas of cold work or high stress present	unlikely to be an issue
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.6**

Flanges
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
36, 37

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for type 304 stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	Medium	Medium	Flange geometries produce crevices. Presence of oxygen and flow accelerate local corrosion.	Oxygen
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and deposits present; flange itself can form a crevice	unlikely to be an issue, but corrosion of flange faces has been seen
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.6**

Flanges
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
36, 37

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs
2	0	High	Medium	thermal fatigue not relevant at these temperatures and vibrations at low flow rates will not result in fatigue	vibrations from pumps close to elbows will influence the loading
3	0	High	High	No fatigue here	
4	Low	High	High	Assuming no cyclic stresses	
5	Low	High	High	likely only if water contaminated with corrosive impurities and high cyclic stresses and/or cold work present	unlikely to be an issue
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming cyclic stresses are not too high	

Subgroup **46.6**

Flanges
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
36, 37

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	Low	Medium	Medium	Pits occur if oxygen present and flow; not extensive. May interact with corrosion fatigue and SCC.	Oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.6**

Flanges
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
36, 37

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	SCC is accelerated with oxygen and flow in crevice geometry. Also, geometry of the flange may produce special intensitifations of stress in addition to welds or cold work.	Oxygen, cold work, impurities
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and areas of cold work or high stress present	unlikely to be an issue
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.7**

Mixed bed components
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
39, 40, 41, 42, 43, 44, 45, 46

Notes: inlet nozzle, head, shell, outlet nozzle, filters, shell

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Crevice corrosion a credible threat for type 304 stainless steel in aerated, acidic water	Crevice geometry with restricted flow
2	Low	High	High	well-known phenomenon; crevices present	
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and deposits or other crevices present	unlikely to be an issue unless resin components present (sulfides)
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.7**

Mixed bed components
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
39, 40, 41, 42, 43, 44, 45, 46

Notes: inlet nozzle, head, shell, outlet nozzle, filters, shell

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base at low temperature	Only likely to be a problem where flow induced vibration occurs
2	0	High	Medium	thermal fatigue not relevant at these temperatures and vibrations at low flow rates will not result in fatigue	smallest dimensions more susceptible than the larger
3	Low	Medium	Medium	Possible vibrations here are not clear but should be evaluated.	vibrations
4	Low	High	High	Assuming no cyclic stresses	
5	Low	High	High	likely only if significant vibration can occur; most likely at joints, etc.	areas at risk are cyclic stress components
6	Low	Medium	Medium	Unlikely unless unexpected sources of cyclic loading occur	Design
7	Low	High	High	Vibration stress can be a cause	Vibration stress
8	Low	High	High	Assuming cyclic stresses are not too high	

Subgroup **46.7**

Mixed bed components
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
39, 40, 41, 42, 43, 44, 45, 46

Notes: inlet nozzle, head, shell, outlet nozzle, filters, shell

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borate solutions	
2	Low	High	High	Well known phenomenon, will occur under stagnant and low flow rate conditions	
3	Medium	Medium	Medium	Possible occurrence of MIC should be considered in view of the large amount of nutrients as well as good temperature range for microbes.	nutrients, temperature range
4	0	High	High		
5	Low	High	High	likely only if water contaminated with corrosive impurities, including bacteria	unlikely here
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Assume treated water with monitoring	Only uner wet condition.
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.7**

Mixed bed components
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
39, 40, 41, 42, 43, 44, 45, 46

Notes: inlet nozzle, head, shell, outlet nozzle, filters, shell

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	Medium	Medium	Medium	Pitting can be produced by presence of oxygen and impurities, such as sulfate, that are well know to be aggressive.	Oxygen, impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	likely only if water contaminated with corrosive impurities	needs oxygenated water and chlorides, or other corrosive anions
6	Low	Medium	Medium	Unlikely (particularly with flow) unless contamination occurs	Water chemistry and flow rate
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **46.7**

Mixed bed components
SS TP 304, 316
Borated water, 70-110°F and 65 psi, 80gpm

Applies to BNL Part #s with prefix SS-SFPCLN
39, 40, 41, 42, 43, 44, 45, 46

Notes: inlet nozzle, head, shell, outlet nozzle, filters, shell

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only seems possible at weldments if significant chloride pollution present	Chloride pollution
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	With complex geometries, high residual stresses should be expected, Presence of impurities and oxygen can produce SCC	High residual stresses, oxygen, impurities
4	Low	High	High	Assuming water quality remains good	
5	Low	High	High	likely only if water contaminated with corrosive impurities and areas of cold work or high stress present	unlikely to be an issue unless resin components present (sulfides)
6	Low	High	High	Unlikely unless contamination occurs	Water chemistry
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use in TP 304 of spent fuel pool	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.1**

Spent fuel pool
TP 304 SS
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce accelerated corrosion in crevices.	crevice geometries, oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >10ppm; crevices between supports and SS
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Low	High	High	Geometrical discontinuity of structure may form crevice	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.1**

Spent fuel pool
TP 304 SS
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Not an issue for SS in water with controlled purity	
4	Low	High	High	General corrosion resistance of stainless steels should be very good in this environment	
5	0	High	High	Not regarded as a credible contribution to significant structural degradation.	
6	Medium	High	High	Degradation of Boraflex racks has occurred in some cases, apparently due to the silicone polymer which contains the B4C dissolving in the borated water. BORAL panels were developed to overcome this problem.	High irradiation levels accelerate dissolution rate
7	Low	High	High	Possible degradtion mechanism and some field experience	Electrochemiocal potential.
8	0	High	High	General corrosion of SS should be very small	

Subgroup **47.1**

Spent fuel pool
TP 304 SS
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce pitting especially associated with crevices.	oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >100ppm
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.1**

Spent fuel pool
TP 304 SS
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low temperature IGSCC of wrought stainless steel unlikely in absence of sensitization or chloride	
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	Medium	Possible if dissolved oxygen content is circa 2 ppm together with grain boundary sensitization and severe stress	
5	Low	High	High	unlikely unless pool contaminated with chloride	chloride contamination >10ppm; high stress areas such as pits, scratches, bends, etc.
6	Low	High	High	Susceptibility would normally be low with correct water chemistry but IGSCC has occurred at top nozzles of some fuel elements (see Sect. 7.3 of Primary Water Chemistry Guidelines, Appendix B)	Relates to release of sulfur compounds from cleanup resin bed as a result of exposure to H2O2 in spent fuel pool water
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.1**

Spent fuel pool
TP 304 SS
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Relative sliding movement necessary for wear seems rather unlikely on a continuous basis	
2	0	High	Medium	no identified loading mode	
3	Low	Medium	Low	Wear geometries but not clear about whether can occur	
4	Medium	Medium	Medium	Inadequate definition of system to make complete judgement. Unclear source of relative motions	
5	Low	High	High	expected to be an issue only if significant cyclic vibrations present in structure	
6	--	--	--	Please remove :Wrong mechanism was chosen previously (GC is probably the closest we have in our list)	
7	Low	Medium	Medium	Possible mode with Spent fuel vibration.	
8	Low	Low	Medium	Unclear that relative motion exists to cause wear	

Subgroup **47.2**

Spent fuel pool
TP 304 SS weld HAZ
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce accelerated corrosion in crevices.	crevice geometries, oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >10ppm; crevices between supports and SS
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Low	High	High	Geometrical discontinuity of structure may form crevice	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.2**

Spent fuel pool
TP 304 SS weld HAZ
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs - unlikely in a fuel pool	Flow induced vibration
2	0	High	Medium	no cyclic loading mode	
3	0	High	High	No fatigue here	
4	Medium	Medium	Medium	Inadequate definition of system to make complete judgement. Unclear source of cyclic stress	
5	Low	High	High	highly unlikely unless design deficient and allows high cyclic stresses	
6	0	Medium	Medium	Little or no significant fatigue loading	
7	Low	High	High	Vibration stress may cause corrosion fatigue	
8	Low	Low	Medium	Unclear that consequential fatigue loading exists	

Subgroup **47.2**

Spent fuel pool
TP 304 SS weld HAZ
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce pitting especially associated with crevices.	oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >100ppm
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Medium	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.2**

Spent fuel pool
TP 304 SS weld HAZ
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Low temperature IGSCC of sensitized stainless steel HAZs could occur after long periods in oxygenated acidic solutions	
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride	chloride contamination >10ppm; high stress areas such as pits, scratches, bends, etc.
6	Medium	High	High	HAZ likely to be preferred location if IGSCC from S species occurs	Relates to release of sulfur compounds from cleanup resin bed as a result of exposure to H2O2 in spent fuel pool water
7	Medium	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.3**

Spent fuel pool
SS weld metal
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce accelerated corrosion in crevices.	crevice geometries, oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >10ppm; crevices between supports and SS
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Low	High	High	Geometrical discontinuity of structure may form crevice	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.3**

Spent fuel pool
SS weld metal
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only likely to be an issue if flow induced vibration occurs - unlikely in a fuel pool	Flow induced vibration
2	0	High	Medium	no cyclic loading mode	
3	0	High	High	No fatigue here	
4	Medium	Medium	Medium	Inadequate definition of system to make complete judgement. Unclear source of cyclic stress	
5	Low	High	High	highly unlikely unless design deficient and allows high cyclic stresses	
6	0	Medium	Medium	Little or no significant fatigue loading	
7	Low	High	High	Vibration stress may cause corrosion fatigue	
8	Low	Low	Medium	Unclear that consequential fatigue loading exists	

Subgroup **47.3**

Spent fuel pool
SS weld metal
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce pitting especially associated with crevices.	oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >100ppm
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Low	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.3**

Spent fuel pool
SS weld metal
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1,2,3,4,5,9

Notes: liner, storage rack, typical cell, storage rack supports

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	I know of no actual or potential low temperature SCC of S/S weld metals under these conditions	
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride	chloride contamination >10ppm; high stress areas such as pits, scratches, bends, etc.
6	Low	High	High	Expect weld metal to be resistant to SCC at this temperature	Avoid off-chemistry situations
7	Low	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.4**

Boral panels
Aluminum
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
7
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Field experience of corrosion but details not known	
2	0	High	Medium	should not be crevices present	
3	Medium	Medium	Medium	Aluminum in crevices with conductive solutions and external oxygen corrodes rapidly	oxygen, impurities
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	aluminum alloys can suffer limited crevice corrosion or pitting at these temperatures; most likely if boral exfoliates	If water temperature near panels increases because of fuel proximity, corrosion rate could be significant
6	Low	High	High	Extensive qualification tests were performed to eliminate this issue	Avoid off-chemistry situations
7	Low	High	High	Depend upon the geometry	Heat treatment is important and water purity. Cl may cause a problem. Local pH
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.4**

Boral panels
Aluminum
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
7
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Well known pH range must be respected to ensure negligible general corrosion	4>pH>8.5
2	0	High	Medium	Assuming water quality remains good	
3	Medium	Medium	Medium	Aluminum in water corrodes especially after long times and in the presence of oxygen and impurities	Aluminum is reactive
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	aluminum alloys experience slow GC at these temperatures; could increase if temperature increased above 200F	If water temperature near panels increases because of fuel proximity, corrosion rate could be significant
6	Low	High	High	Extensive qualification tests were performed to eliminate this issue	Avoid off-chemistry situations
7	Low	High	High	In general, very good field experience so far.	Heat treatment is important and water purity. Cl may cause a problem. Local pH
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.4**

Boral panels
Aluminum
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
7
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Known sensitivity to presence of traces of copper, carbonate and chloride. Once initiated, pitting will continue in neutral conditions	Presence of impurities, particularly chloride and copper.
2	Low	High	High	Field experience of exfoliation	
3	Medium	Medium	Medium	Aluminum, especially with boron in the matrix will corrode intergranularly to produce exfoliation geometries.	grain boundaries
4	Low	High	High	Field experience of exfoliation	
5	Low	High	High	Field experience of exfoliation of Boral coating could expose aluminum to pool water	If water temperature near panels increases because of fuel proximity, corrosion rate could be significant
6	Low	High	High	Extensive qualification tests were performed to eliminate this issue	Avoid off-chemistry situations
7	Low	Medium	Medium	Field experience of exfoliation	Heat treatment is important and water purity. Cl may cause a problem. Local pH
8	Low	High	High	Field experience of exfoliation	

Subgroup **47.5**

Fuel Assembly
Zr- alloy
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
8

Notes: Fuel rods/cladding matls.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	General corrosion of irradiated zircaloy negligible in properly controlled fuel pool water	
2	Low	High	Medium	could be an issue with high burn up fuel	
3	0	High	High	Zr very corrosion resistant	
4	Medium	Medium	Medium	General and localized corrosion of cladding has occurred in core service. Unclear as to the effect of this prior damage on subsequent damage in the fuel pool over extended period of time	
5	Low	High	High	unlikely for Zr alloys unless corrosive impurities/contamination possible (nickel, caustic?)	
6	0	Medium	Medium	Rates of GC are vanishingly small for Zr alloys under these conditions	
7	Low	High	High	Possible degradation mode	
8	Medium	High	High	Known issues with corrosion and oxide thickness as higher burn-up fuel is used	

Subgroup **47.5**

Fuel Assembly
Zr- alloy
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
8

Notes: Fuel rods/cladding matls.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	Medium	Medium	I know of no long term low temperature storage SCC mechanisms for zircaloy. The irradiated stainless steel and nickel base alloy parts of fuel elements (with irradiation induced grain boundary Cr depletion) could be vulnerable, however	
2	0	High	Medium	temperature too low	
3	Low	Medium	Medium	SCC may depend on forces inside the fuel elements. Otherwise no SCC.	Internal stresses.
4	0	High	High	Not a known mechanism in this environment	
5	Low	High	High	unlikely unless corrosive impurities such as iodine present	
6	Low	High	High	Unlikely because of low temperature	Avoid off-chemistry situations
7	Low	High	High	Increase in pressure of clad may cause SCC but in general, very unlikely to occur	Internal pressure
8	Low	High	High	Zr alloys quite immune in this environment	

Subgroup **47.6**

Spent Fuel Pool
floor with SS liner
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	0	High	Medium	should not be crevices present	
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce accelerated corrosion in crevices.	crevice geometries, oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >10ppm; crevices between supports and SS
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Low	High	High	Geometrical discontinuity of structure may form crevice by corrosion product	Geometry and Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.6**

Spent Fuel Pool
floor with SS liner
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Significant Fatigue forces applied to fuel pool floor seem very unlikely	
2	0	High	Medium	no cyclic loading mode	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	Assume minimal cyclic loading	
5	Low	High	High	highly unlikely unless design deficient and allows high cyclic stresses	
6	0	Medium	Medium	Little or no significant fatigue loading	
7	Low	High	High	Need to identify the caiuse of stress	
8	Low	High	High	Fatigue loading assumed to be minimal	

Subgroup **47.6**

Spent Fuel Pool
floor with SS liner
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in borated water	Nutrients
2	Medium	High	High	will occur if stagnant or near stagnant water	
3	Low	Medium	Medium	Microbes may accumulate in view of presence of nutrients.	
4	0	High	High	boric acid and irradiation makes this degradation mode unlikely	
5	Medium	High	High	possible under deposits or on welds; has been seen in service	
6	0	Medium	Medium	Nothing in high-purity borated water to feed the bugs	Avoid off-chemistry situations
7	Low	High	High	Assume treated water	
8	Low	High	High	Always a concern, but proper chemistry control and presence of boric acid makes MIC unlikely	

Subgroup **47.6**

Spent Fuel Pool
floor with SS liner
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No known problems for stainless steels even in concentrated aerated boric acid unless contaminated by chloride	Chloride contamination
2	0	High	Medium	Assuming water quality remains good	
3	Low	Medium	Medium	Complex geometries, variable flows locally, oxygen, impurities can produce pitting especially associated with crevices.	oxygen
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride; occurs in crevices or under deposits	chloride contamination >100ppm
6	Low	Medium	Medium	Susceptibility low in absence of contamination	Avoid off-chemistry situations
7	Medium	High	High	Several field experiences of leak due to PIT(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.6**

Spent Fuel Pool
floor with SS liner
High purity Borated water with oxygen
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low temperature IGSCC of wrought stainless steel very unlikely in absence of sensitization or chloride	
2	Low	High	High	unlikely at this temperature	Impurities, dissolved oxygen and surface finish important
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	Assume that correct water Chem is maintained	
5	Low	High	High	unlikely unless pool contaminated with chloride	chloride contamination >10ppm; high stress areas such as pits, scratches, bends, etc.
6	Low	High	High	Expect low stress liner to be resistant to SCC at this temperature	Avoid off-chemistry situations
7	Medium	High	High	Several field experiences of leak due to SCC(?) cause by Cl contamination during fabrication and other process before use.	Cl contamination
8	Low	High	High	Assuming water quality remains good	

Subgroup **47.7**

Spent Fuel Pool
floor with SS liner
Humid air, gamma radiation, external surface
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Generation of nitric acid from irradiated humid air could lead to crevice corrosion	Humidity and crevice geometry
2	Low	High	High	Well known phenomenon, will occur under stagnant conditions	contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Some crevice corrosion will occur but not much	Check for crevice locations
4	Low	High	High	Assumes water quality (e.g., Cl) is good	
5	Medium	High	High	possible under deposits	
6	Low	Medium	Medium		
7	Low	High	High	Crevice may form between pool floor and spent fuel	
8	Low	High	High	Assumes water quality (e.g., Cl) is good	

Subgroup **47.7**

Spent Fuel Pool
floor with SS liner
Humid air, gamma radiation, external surface
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Pitting not so much a threat as SCC and CREV in nitric acid generated from irradiated humid air	Humidity
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Low	High	High	Pitting not likely to be significant	
4	Low	High	High	Assumes water quality (e.g., Cl) is good	
5	Medium	High	High	possible under deposits	
6	Low	High	High		
7	Low	High	High	Chloride concentration may cause PIT	
8	Low	High	High	Assumes water quality (e.g., Cl) is good	

Subgroup **47.7**

Spent Fuel Pool
floor with SS liner
Humid air, gamma radiation, external surface
100 - 150°F, Ambient pressure

Applies to BNL Part #s with prefix AS-SFPRACK
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Generation of nitric acid from irradiated humid air could cause IGA and IGSCC	Humidity
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	0	Medium	Low	SCC has been observed in boric acid but at high concentrations	
4	Low	High	Medium	Humid air and radiation can produce HNO3, but SCC is unlikely in unsensitized SS.	
5	Low	High	High	possible under deposits because of oxidizing conditions and moisture; highly stressed areas at risk (e.g. welds and cold work)	
6	Medium	High	High	Potential vulnerability as a result of HNO3 formation from radiolysis of moist air	
7	Low	High	High	Under wet condition by condensation	
8	Low	High	Medium	Humid air and radiation can produce HNO3, but SCC is unlikely in unsensitized SS.	

Subgroup **48.1**

TP 304, LAS, CS (Base metal, HAZ and Weld Metal except 304)
Ambient air and pressure,
Possible concentration of impurities such as Cl (outside)

Applies to BNL Part #s with prefix ESF-CONTPEN

Liner, Sleeves, Penetration pipes, Flued head/piping, Leak chase channel plugs, Flange, Necked flange, Fastner bolts/nuts

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anions such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Complex geometries and oxygenated solution will produce some accelerated corrosion in crevices	Oxygen and crevice
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	Medium	Medium	Sleeve/container concrete interface is a potential problem for LAS and CS associate with concrete neutralization	Rebar corrosion is well known but mostly outside building which can be wet by rain etc.
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.1**

TP 304, LAS, CS (Base metal, HAZ and Weld Metal except 304)
Ambient air and pressure,
Possible concentration of impurities such as Cl (outside)

Applies to BNL Part #s with prefix ESF-CONTPEN

Liner, Sleeves, Penetration pipes, Flued head/piping, Leak chase channel plugs, Flange, Necked flange, Fastner bolts/nuts

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for wrought materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Design
7	0	High	High	No significant cyclic stress	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.1**

TP 304, LAS, CS (Base metal, HAZ and Weld Metal except 304)
Ambient air and pressure,
Possible concentration of impurities such as Cl (outside)

Applies to BNL Part #s with prefix ESF-CONTPEN

Liner, Sleeves, Penetration pipes, Flued head/piping, Leak chase channel plugs, Flange, Necked flange, Fastner bolts/nuts

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of stainless & non-stainless steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	0	High	High	Outside not significant. Some rusing possibly.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.1**

TP 304, LAS, CS (Base metal, HAZ and Weld Metal except 304)
Ambient air and pressure,
Possible concentration of impurities such as Cl (outside)

Applies to BNL Part #s with prefix ESF-CONTPEN

Liner, Sleeves, Penetration pipes, Flued head/piping, Leak chase channel plugs, Flange, Necked flange, Fastner bolts/nuts

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Low	Medium	Medium	This temperature range and lack of boric acid together with access to outside could produce MIC	Nutrients, temperature
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.1**

TP 304, LAS, CS (Base metal, HAZ and Weld Metal except 304)
Ambient air and pressure,
Possible concentration of impurities such as Cl (outside)

Applies to BNL Part #s with prefix ESF-CONTPEN

Liner, Sleeves, Penetration pipes, Flued head/piping, Leak chase channel plugs, Flange, Necked flange, Fastner bolts/nuts

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anions such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Some pits will occur in the crevices or under deposits. Also, locally varying flows and oxygenation will produce pits	Oxygen, impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped. (2)Straip current exist between sleeves and concrete.	Any possibility of water moisture condensation and strap current due to insulator degradation of electrical cable through electrical penetration
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.1**

TP 304, LAS, CS (Base metal, HAZ and Weld Metal except 304)
Ambient air and pressure,
Possible concentration of impurities such as Cl (outside)

Applies to BNL Part #s with prefix ESF-CONTPEN

Liner, Sleeves, Penetration pipes, Flued head/piping, Leak chase channel plugs, Flange, Necked flange, Fastner bolts/nuts

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC possible for SS in presence of chloride with high residual stresses and cold work.	High residual stresses, chloride pollution
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.2**

TP 304 sleeves (SA-316, Gr. 60 & SA-335, Gr.6) dissimilar weld
Ambient air and pressure
Possible concentration of impurities such as Cl
Possible use of buttering by Ni-base alloy

Applies to BNL Part #s with prefix ESF-CONTPEN
Containment Liner Material
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Complex geometries and oxygenated solution will produce some accelerated corrosion in crevices	Oxygen and crevice
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions; rating of 2 based on possibility of nitric acid corrosion of support/contacting materials that might affect liner	surface contamination with deposits/impurities; nitric acid can be generated by reaction of gamma fields with moist air presence in annulus space around liner
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	Medium	Medium	Sleeve/container concrete interface is a potential problem for LAS and CS associate with concrete neutralization	Rebar corrosion is well known but mostly outside building which can be wet by rain etc.
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.2**

TP 304 sleeves (SA-316, Gr. 60 & SA-335, Gr.6) dissimilar weld
Ambient air and pressure
Possible concentration of impurities such as Cl
Possible use of buttering by Ni-base alloy

Applies to BNL Part #s with prefix ESF-CONTPEN
Containment Liner Material
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for wrought materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Low	High	Medium	Assume lab data base for wrought materials applies.	Only likely to be a problem where flow induced vibration occurs during use
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Design
7	0	High	High	No significant cyclic stress	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.2**

TP 304 sleeves (SA-316, Gr. 60 & SA-335, Gr.6) dissimilar weld
Ambient air and pressure
Possible concentration of impurities such as Cl
Possible use of buttering by Ni-base alloy

Applies to BNL Part #s with prefix ESF-CONTPEN
Containment Liner Material
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of stainless and non-stainless steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	0	High	High	Outside not significant. Some rusing possibly.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.2**

TP 304 sleeves (SA-316, Gr. 60 & SA-335, Gr.6) dissimilar weld
Ambient air and pressure
Possible concentration of impurities such as Cl
Possible use of buttering by Ni-base alloy

Applies to BNL Part #s with prefix ESF-CONTPEN
Containment Liner Material
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Low	Medium	Medium	This temperature range and lack of boric acid together with access to outside could produce MIC	Nutrients, temperature
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.2**

TP 304 sleeves (SA-316, Gr. 60 & SA-335, Gr.6) dissimilar weld
Ambient air and pressure
Possible concentration of impurities such as Cl
Possible use of buttering by Ni-base alloy

Applies to BNL Part #s with prefix ESF-CONTPEN
Containment Liner Material
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Some pits will occur in the crevices or under deposits. Also, locally varying flows and oxygenation will produce pits	Oxygen, impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped. (2)Straip current exist between sleeves and concrete.	Any possibility of water moisture condensation and strap current due to insulator degradation of electrical cable through electrical penetration
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.2**

TP 304 sleeves (SA-316, Gr. 60 & SA-335, Gr.6) dissimilar weld
Ambient air and pressure
Possible concentration of impurities such as Cl
Possible use of buttering by Ni-base alloy

Applies to BNL Part #s with prefix ESF-CONTPEN
Containment Liner Material
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC possible at stainless and dissimilar metal welds in presence of chloride with high residual stresses and cold work.	High residual stresses, chloride pollution
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	Temperature at low end of SCC. Possible SCC with high residual stresses and cold work.	High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.1**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Inside:Main steam/Feed water, 557°F, 1092-1185psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	should not be any crevices	
3	Low	High	High	Not likely without oxygen	
4	Low	High	High	These are educated "guesses" based on description of system	
6	--	--	--	Was not evaluated in groups 24 and 25 so does not seem relevant here	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.1**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Inside:Main steam/Feed water, 557°F, 1092-1185psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Low	Medium	Medium	Good field experience so far but a few failures attributed to fatigue have occurred	High vibration
4	Low	High	High	These are educated "guesses" based on description of system	
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	Medium	Medium	Good lab data base but uncertainty on accounting for magnitude of environmental effects in the field and thermal stress	Very good field experience. Only likely to be a problem where present design rules give CUF>0.1approx.
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.1**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Inside:Main steam/Feed water, 557°F, 1092-1185psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	not a problem at these temperatures	
3	Low	High	High	Outside not significant. Some rusing possibly.	
4	Low	High	High	These are educated "guesses" based on description of system	
6	--	--	--	Was not evaluated in groups 24 and 25 so does not seem relevant here	
7	Medium	Medium	Medium	Corrosion rate is well characterized but semi-local corrosion rate depending upon flow pattern and velocity are not well characterized.	Velocity and flow pattern
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.1**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Inside:Main steam/Feed water, 557°F, 1092-1185psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	0	High	High	Not at these temperatures	
4	Low	High	High	These are educated "guesses" based on description of system	
6	--	--	--	Was not evaluated in groups 24 and 25 so does not seem relevant here	
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.1**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Inside:Main steam/Feed water, 557°F, 1092-1185psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	high flow rates	
3	Low	High	High	Not likely without chloride	
4	Low	High	High	These are educated "guesses" based on description of system	
6	--	--	--	Was not evaluated in groups 24 and 25 so does not seem relevant here	
7	Medium	Medium	Medium	Local cell formation cause by local potential variation associate with flow may cause pit,	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.1**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Inside:Main steam/Feed water, 557°F, 1092-1185psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	High	High	Probably not an issue	
3	Low	Medium	Medium	Carbon steel sustains SCC at these temperatures but usually at higher oxygen. However, presence of pits may initiate SCC even in absence of oxygen.	Conditions for SCC should be investigated.
4	Low	High	High	These are educated "guesses" based on description of system	
6	Low	High	High	Possible for CS but unlikely at steam or MFW conditions (c.f. groups 24 & 25)	high residual stress/welds, bends, etc.
7	Low	High	High	Potential problem in long term degradation	Stress and oxidation inhomogenuity causing local stress concentration
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.2**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Outside:Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	0	High	Medium	should not be any crevices	
3	Low	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials	Moisture and crevices
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Crevice can be caused between pipes and feed water line penetration.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.2**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Outside:Cooled air, Temperature below 150°F
and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for carbon and low alloy steels at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Low	Medium	Medium	Corrosion fatigue occurs if sufficient stress and cycles present. Accelerated if stress cycle is low frequency	Cyclic stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	Medium	Potential problem when thermal stress changes are significant	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.2**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Outside:Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Low	Medium	Medium	GC occurs if moisture present and accelerated if impurities present	Moisture and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Potential problem but very unlikely	Humidity of cooling air. Normally dry
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.2**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Outside:Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Low	Medium	Medium	MIC is possible at these temperatures and the microbes must produce corrosive species. Moisture required and nutrients required	Moisture and nutrients
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.2**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Outside:Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	0	High	Medium	high flow rates	
3	Low	Medium	Medium	Cool outside surfaces may accumulate moisture and impurities. Contributions for insulation are not clear.	Presence of water and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume wet condition	under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.3.2**

Penetration pipes (MS and FW)
SA155 GR. NCGS and SA106, GR.B
Outside:Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Main Steam Line Penetration and Feedwater Line Penetration

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. Accelerated by low frequency cyclic ripple.	Water or wetness. Contributions from sources of impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Thermal stress can be a cause of SCC	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.1**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Inside:Primary water, Temp. 350°F - 165°F,
Pressure 450 - 75/100 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Lines CVCS Line Penetration
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	should not be any crevices	
3	Low	High	High	Not likely without oxygen	
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this component…I don't think this is any different from 48.4B?	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.1**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Inside:Primary water, Temp. 350°F - 165°F,
Pressure 450 - 75/100 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Lines CVCS Line Penetration
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Low	Medium	Low	Not aware of significant information of conditions for corrosion fatigue. Any cyclic stressing is likely to stimulate the SCC especially if the frequency is 1Hz or less. Assume that what is considered here is nominal water chemistry.	Most important when contributes to SCC as cyclic superposition.
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this component…I don't think this is any different from 48.4B?	
6	--	--	--	assessments should be the same as those made earlier for the rest of the system	
7	Low	High	High	Potential problem but no significant stress changes	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.1**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Inside:Primary water, Temp. 350°F - 165°F,
Pressure 450 - 75/100 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Lines CVCS Line Penetration
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	not a problem at these temperatures	
3	Low	High	High	Outside not significant. Some rusing possibly.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this component…I don't think this is any different from 48.4B?	
6	--	--	--	and may vary according to the medium in individual lines anyway.	
7	0	High	High	Not an issue for SS	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.1**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Inside:Primary water, Temp. 350°F - 165°F,
Pressure 450 - 75/100 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Lines CVCS Line Penetration
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	0	High	High	Not at these temperatures	
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this component…I don't think this is any different from 48.4B?	
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.1**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Inside:Primary water, Temp. 350°F - 165°F,
Pressure 450 - 75/100 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Lines CVCS Line Penetration
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	0	High	Medium	high flow rates	
3	Low	High	High	Not likely without chloride	
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this component…I don't think this is any different from 48.4B?	
7	Low	High	High	Local cell formation cause by local potential variation associate with flow may cause pit,	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.1**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Inside:Primary water, Temp. 350°F - 165°F,
Pressure 450 - 75/100 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Lines CVCS Line Penetration
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	High	High	unlikely at this temperature	
3	Low	High	Medium	Evidence from INSS as well as other lab shows that stainless steels sustain IGSCC in hydrogenated water in the non-sensitized condition. The SCC is slow but finite. Such SCC would be accelerated by cold work, high residual stresses, and abusive conditions	Longer times, surface dings and dents cyclic stressing, abusive machining, cold work, high residual stresses.
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this component…I don't think this is any different from 48.4B?	
6	--	--	--	See no reason to rank these collectively here under penetrations -	
7	Low	High	High	Potential problem in long term degradation	Stress or dynamic loading
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.2**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Outside:Cooled air
Temperature below 150 F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Line, CVCS Line Penetration
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	0	High	Medium	should not be any crevices	
3	Low	High	High	Some possible if crevices. Ample oxygen	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Crevice can be caused between pipes and feed water line penetration.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.2**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Outside:Cooled air
Temperature below 150 F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Line, CVCS Line Penetration
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good data base for weldments of these materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	Medium	Potential problem when thermal stress changes are significant	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.2**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Outside:Cooled air
Temperature below 150 F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Line, CVCS Line Penetration

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of stainless and non-stainless steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Low	High	High	Outside not significant. Some rusting possibly.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Potential problem but very unlikely	Humidity of cooling air.
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.2**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Outside:Cooled air
Temperature below 150 F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Line, CVCS Line Penetration

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Low	High	High	Possible at these temperatures	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.2**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Outside:Cooled air
Temperature below 150 F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Line, CVCS Line Penetration

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	0	High	Medium	high flow rates	
3	Low	High	High	Chloride likely or similar contaminants	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume wet condition	under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.4.2**

Penetration pipes (RHR, SI, CVCS)
TP 304, TP 316L
Outside:Cooled air
Temperature below 150 F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
RHR Line, Safety Injection Line, CVCS Line Penetration
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC possible at stainless and dissimilar metal welds in presence of chloride with high residual stresses and cold work.	High residual stresses, chloride pollution
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Potential problem when cooling gas quality kept out of specification for a long time. Cl may concentrate.	Cooling gas quality
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.1**

Penetration pipes (SW and CCW)
SA106, GR.B
Temperature 130°F, Pressure 75/100 - 150 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in correctly treated water	Oxygen, impurities
2	0	High	Medium	should not be any crevices	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this item; surely only air on both sides? Same as 48.4B?	
7	Low	Medium	Medium	Sleeve/container concrete interface is a potential problem for LAS and CS associate with concrete neutralization	Rebar corrosion is well known nut mostly outside building which can be wet by rain etc.
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.1**

Penetration pipes (SW and CCW)
SA106, GR.B
Temperature 130°F, Pressure 75/100 - 150 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely that properly treated deoxygenated water has any significant effect on fatigue properties at low temperature	Oxygen, impurities
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this item; surely only air on both sides? Same as 48.4B?	
6	--	--	--	assessments should be the same as those made earlier for the rest of the system	
7	0	High	High	No significant cyclic stress	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.1**

Penetration pipes (SW and CCW)
SA106, GR.B
Temperature 130°F, Pressure 75/100 - 150 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Nothing abnormal expected in correctly treated water	Failure of water treatment
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this item; surely only air on both sides? Same as 48.4B?	
6	--	--	--	and may vary according to the medium in individual lines anyway.	
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.1**

Penetration pipes (SW and CCW)
SA106, GR.B
Temperature 130°F, Pressure 75/100 - 150 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC unlikely in properly treated flowing water	Presence of nutrients under deposits
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this item; surely only air on both sides? Same as 48.4B?	
7	Low	High	High	Assume treated water with monitoring	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.1**

Penetration pipes (SW and CCW)
SA106, GR.B
Temperature 130°F, Pressure 75/100 - 150 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting less likely in flowing systems	Oxygen, impurities
2	0	High	Medium	high flow rates	
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this item; surely only air on both sides? Same as 48.4B?	
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped. (2)Straip current exist between sleeves and concrete.	Any possibility of water moisture condensation and strap current due to insulator degradation of electrical cable through electrical penetration
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.1**

Penetration pipes (SW and CCW)
SA106, GR.B
Temperature 130°F, Pressure 75/100 - 150 psi

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in deoxygenated treated water at low temperature without prolonged presence of unauthorized chemicals	Oxygen, impurities
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	--	--	--	cannot rate this item; surely only air on both sides? Same as 48.4B?	
6	--	--	--	See no reason to rank these collectively here under penetrations -	
7	Low	High	High	SCC can potentially happen when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.5.2**

Penetration pipes (SW and CCW)
SA106, GR.B
Outside: Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion not an issue in properly made concrete.	
2	Low	High	High	Possible crevice on external surface.	
4	Low	Medium	Medium	Maybe in aerated , marine environments	
5	Low	High	High	As long as concrete remains "dry" and alkaline, no crevice corrosion is anticipated.	
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Carbon steels contacting with an container concrete may subject to crevice corrosion after neutralization of the concrete	pH and water penetration
8	Low	High	High		

Subgroup **48.5.2**

Penetration pipes (SW and CCW)
SA106, GR.B
Outside: Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume cyclic loads within code allowable	
2	0	High	High	No non-design loading conditions relevant to fatigue.	
4	Low	High	High	No obvious source of cyclic stress	
5	Low	High	High	Typically these components would not be expected to experience significant vibration	
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Thermal fatigue is possile mechanism	Environmental effects may increase an usage factor
8	Low	High	High		

Subgroup **48.5.2**

Penetration pipes (SW and CCW)
SA106, GR.B
Outside: Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	GC very low in contact with Portland cement concrete	
2	0	High	High	Not a problem at these temperatures.	
4	Low	Medium	Medium	alkaline environment of pH >10 likely in condensate (for portland cements). Good corrosion resistance expected in this environment. Lower C and K scores mirroring the unknown counter effect of chloride contamination (in aerated marine environments)	
5	Low	High	High	Because of dry environment this is expected to be insignificant	
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Carbon steels contacting with an container concrete may corrode after neutralization of the concrete	pH and water penetration
8	Low	High	High		

Subgroup **48.5.2**

Penetration pipes (SW and CCW)
SA106, GR.B
Outside: Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Localized corrosion known to occur at air concrete interface when wetted	
2	Low	High	High	Possible crevice on external surface.	
4	Low	Medium	Medium	Maybe in aerated , marine environments	
5	Low	High	High	Seems low probability based on dry environment and lack of corrosive impurities	
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Carbon steels contacting with an container concrete may subject to pitting corrosion after neutralization of the concrete	pH and water penetration
8	Low	High	High		

Subgroup **48.5.2**

Penetration pipes (SW and CCW)
SA106, GR.B
Outside: Cooled air, Temperature below 150°F and ambient pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely in contact with concrete	
2	Low	High	High	Not a problem at these temperatures unless pitting occurs or crevice present.	
4	Low	High	High	Unlikely in the silicate/ hydoxide liquide condensate that might form at the contact point, especially since low stress is expectedthat	
5	Low	High	High	Seems low probability based on dry environment and lack of corrosive impurities	
6	0	Medium	Medium	Not likely in carbon steels at this temperatutre	
7	Low	High	High	Potential problem but very unlikely	High residuaal stress at welds
8	Low	High	High		

Subgroup **48.6**

Penetration pipes/sleeves dissimilar weld, HAZ (SW and CCW)
TP 304 & 316L, LAS & CS
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	Not likely without oxygen	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Potential problem of LAS and CS when surface is wet for a long time	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.6**

Penetration pipes/sleeves dissimilar weld, HAZ (SW and CCW)
TP 304 & 316L, LAS & CS
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good data base for weldments of these materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	0	Medium	Low	Unlikely at these temperatures	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Temperature change is not large and very unlikely	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.6**

Penetration pipes/sleeves dissimilar weld, HAZ (SW and CCW)
TP 304 & 316L, LAS & CS
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of stainless and non-stainless steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Low	High	High	Some rusing possibly. Not significant.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High		
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.6**

Penetration pipes/sleeves dissimilar weld, HAZ (SW and CCW)
TP 304 & 316L, LAS & CS
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Low	High	High	Possible at these temperatures	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.6**

Penetration pipes/sleeves dissimilar weld, HAZ (SW and CCW)
TP 304 & 316L, LAS & CS
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	0	High	Medium	high flow rates	
3	Low	High	High	Pitting of SS also occurs with impurities and wetness but these are not normal. Pitting is particularly important since it can lead to initiating corrosion fatigue as well as SCC while the pitting itself is not likely to perforate.	Exposure to wetness and impurities.
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High		
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.6**

Penetration pipes/sleeves dissimilar weld, HAZ (SW and CCW)
TP 304 & 316L, LAS & CS
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Service Water Line and Component Cooling Water Line Penetration

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC possible at stainless and dissimilar metal welds in presence of chloride with high residual stresses and cold work.	High residual stresses, chloride pollution
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Low	High	High	While SS can sustain SCC and pitting readily when surfaces are contaminated at low temperatures, the conditions for both are not likely in a normally operating plant in the primary system.	Both pitting and SCC would occur if the surfaces are wet and especially if the wetting contained contaminated moisture or if the surface was warm enough to evaporate water
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Depending upon air quality but very unlikely	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.7**

Sleeves & Flued Head (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs & Flued Head (LAS & CS)
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.7**

Sleeves & Flued Head (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs & Flued Head (LAS & CS)
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for carbon and low alloy steels at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	design
7	Low	High	High	Possible temperature variation at Flued Head	Thermal fatigue
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.7**

Sleeves & Flued Head (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs & Flued Head (LAS & CS)
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.7**

Sleeves & Flued Head (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs & Flued Head (LAS & CS)
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.7**

Sleeves & Flued Head (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs & Flued Head (LAS & CS)
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.7**

Sleeves & Flued Head (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs & Flued Head (LAS & CS)
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.8**

Sleeves/Flued Head HAZ (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleeves/Flued Head HAZ (LAS & CS)
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.8**

Sleeves/Flued Head HAZ (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleeves/Flued Head HAZ (LAS & CS)
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good data base for weldments of these materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Possible temperature variation at Flued Head	Thermal fatigue
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.8**

Sleeves/Flued Head HAZ (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleeves/Flued Head HAZ (LAS & CS)
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.8**

Sleeves/Flued Head HAZ (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleeves/Flued Head HAZ (LAS & CS)
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.8**

Sleeves/Flued Head HAZ (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleeves/Flued Head HAZ (LAS & CS)
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.8**

Sleeves/Flued Head HAZ (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleeves/Flued Head HAZ (LAS & CS)
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.9**

Sleeves/Flued Head weld (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs/Flued Head weld (LAS & CS)
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.9**

Sleeves/Flued Head weld (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs/Flued Head weld (LAS & CS)
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for carbon and low alloy steels at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Possible temperature variation at Flued Head	Thermal fatigue
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.9**

Sleeves/Flued Head weld (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs/Flued Head weld (LAS & CS)
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.9**

Sleeves/Flued Head weld (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs/Flued Head weld (LAS & CS)
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.9**

Sleeves/Flued Head weld (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs/Flued Head weld (LAS & CS)
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.9**

Sleeves/Flued Head weld (LAS & CS)
SA-316, Gr. 60, SA-335, Gr.6, SA-350 GR LF-1,
SA-240, GR.304 & SA516 GR. 60
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration sleevs/Flued Head weld (LAS & CS)
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.10**

Leak chase channel plug
Containment air
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Leak Chase Channel Plug

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	High	High	Not likely	
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.10**

Leak chase channel plug
Containment air
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Leak Chase Channel Plug

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for wrought materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	--	--	--	Material???	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	High	High	Not likely	
7	Low	High	Medium	Potential problem when thermal stress changes are significant	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.10**

Leak chase channel plug
Containment air
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Leak Chase Channel Plug

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	High	High	Not likely	
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.10**

Leak chase channel plug
Containment air
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Leak Chase Channel Plug

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	High	High	Not likely	
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.10**

Leak chase channel plug
Containment air
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Leak Chase Channel Plug

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	High	High	Not likely	
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.10**

Leak chase channel plug
Containment air
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Leak Chase Channel Plug

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	--	--	--	cannot assess without material information	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	High	High	Not likely	
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.11**

Flange and necked flange
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flanges

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.11**

Flange and necked flange
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flanges

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for wrought materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Possible temperature variation at Flued Head	Thermal fatigue
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.11**

Flange and necked flange
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flanges

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.11**

Flange and necked flange
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flanges

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.11**

Flange and necked flange
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flanges

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.11**

Flange and necked flange
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flanges

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.12**

Flange and necked flange/sleeves weld HAZ
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld HAZ

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.12**

Flange and necked flange/sleeves weld HAZ
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld HAZ

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good data base for weldments of these materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Possible temperature variation at Flued Head	Thermal fatigue
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.12**

Flange and necked flange/sleeves weld HAZ
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld HAZ

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.12**

Flange and necked flange/sleeves weld HAZ
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld HAZ

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.12**

Flange and necked flange/sleeves weld HAZ
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld HAZ

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when (1)Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.12**

Flange and necked flange/sleeves weld HAZ
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld HAZ

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.13**

Flange and necked flange/sleeves weld metal
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld metal

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice corrosion possible in complex geometries in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if crevice surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.13**

Flange and necked flange/sleeves weld metal
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld metal

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good data base for weldments of these materials at low temperatures. No environmental effect anticipated unless pitting occurs	Cyclic loading
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Observed in the field	Occurs where stresses are high, stress intensifications, abused surfaces, cold work
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	can occur at highly stressed areas subject to cyclic stress	surface contamination with deposits/impurities
6	Low	Medium	Medium	Conceivable that cyclic loading could be enhanced at containment penetrations	design
7	Low	High	High	Possible temperature variation at Flued Head	Thermal fatigue
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.13**

Flange and necked flange/sleeves weld metal
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld metal

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and not an issue unless wetted and contaminated by chlorides, sulfates etc	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.13**

Flange and necked flange/sleeves weld metal
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld metal

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	MIC possible if moisture and nutrients available and oxygen excluded	Nutrients, deoxygenated
2	0	High	Medium	Concern only if wet. Can be managed with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with bacteria and/or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.13**

Flange and necked flange/sleeves weld metal
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld metal

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time.	Concern only if wet. Can be managed with good practice.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	Medium	PIT is a potential problem when Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.13**

Flange and necked flange/sleeves weld metal
SA 105 or SA 305 GR. LF2
Ambient temp and pressure

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Flange and necked flange/sleeves weld metal

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	SCC very likely in carbon and low alloy steels under these ambient conditions	
2	0	High	Medium	not a problem at these temperatures	
3	Medium	Medium	Medium	SCC at near room temperature in range of 90-150F is possible and has been observed in water environments. Could reasonably occur in moist environments especially in view of ready availability of oxygen. The SCC is especially likely if pitting initiates	SCC propagates especially if initial pits. High residual stresses
4	Low	High	High	These are educated "guesses" based on description of system	
5	Low	High	High	only a problem if surfaces wet and contaminated with chlorides or other corrosive anions/deposits	surface contamination with deposits/impurities
6	Low	Medium	Medium	Potential for problems definitely exists here, but have little personal knowledge of issues	Likely to be design and cleanliness
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.14**

Containment Bldg penetrations
Carbon steel bellows
Outside or auxiliary building air

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Bellows
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Only possible on outside surfaces exposed to air if crevices allow water (from leaks or rain) to accumulate	Crevices and presence of water
2	Low	High	High	well-known phenomenon if wet; crevices present	
3	Medium	Medium	Medium	Crevice corrosion could occur on steel if crevices present from deposits or adjacent materials. Crevice corrosion produces hydrogen that may lead to hydrogen embrittlement. In valves, there may be additional crevices	Crevices of mechanical or deposit origin; presence of oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	possible if deposits and moisture collect in bellows convolutions; and if outside air contains sufficient contamination	moisture condensing on bellows surfaces
6	Low	Medium	Medium	Bellows are always a potential weak spot	
7	Low	High	High	Geometrical change may provide a crevice condition. Wet condition is very unlikely.	
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.14**

Containment Bldg penetrations
Carbon steel bellows
Outside or auxiliary building air

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Bellows
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Good lab data base for carbon steels at low temperatures. No environmental effect anticipated unless pitting occurs	
2	0	High	Medium	no non-design loading conditions relevant to fatigue	
3	Medium	Medium	Medium	Cyclic stressing, stress concentrations, oxygen	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	bellows failures common if surfaces can get moist and bellows subject to cyclic stress	moisture condensing on bellows surfaces; cyclic stresses
6	Low	Medium	Medium	Bellows are always a potential weak spot	Design and fabrication
7	Low	Medium	Medium	Need quantify the degree of thermal expansion and thermal stress analysis caused by s-u and s-d	Design must taken into account this thermal expansion change.
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.14**

Containment Bldg penetrations
Carbon steel bellows
Outside or auxiliary building air

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Bellows
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Atmospheric general corrosion of carbon and low alloy steels is well known and could be significant if they remain unprotected outside	Effectiveness of protection, paint etc outside
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Medium	Medium	Medium	Environment is oxygenated. General corrosion may produce hydrogen and accelerate SCC.	Oxygen and impurities
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	likely if ambient moist	
6	Low	Medium	Medium	Bellows are always a potential weak spot	
7	Low	High	High	GC is a potential problem when Cl contamination and wet condition are overlapped	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.14**

Containment Bldg penetrations
Carbon steel bellows
Outside or auxiliary building air

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Bellows
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Can't see conditions suitable for MIC developing on pipes exposed to air	
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	
3	Medium	Medium	Medium	The water in these pipes might be stagnant and a good location for MIC. Whether MIC would occur and the conditions would be right is not clear. Further, the microbes must produce corrosive species and not all do so.	Acid producing microbes
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	possible if deposits and moisture collect in bellows convolutions; and if outside air contains sufficient contamination and bacteria	moisture condensing on bellows surfaces; ambient outside air often contains sufficient bacteria and fungi to initiate colonies
6	Low	Medium	Medium	Bellows are always a potential weak spot	
7	Low	High	High	Assume treated water with monitoring	only under leak condition
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.14**

Containment Bldg penetrations
Carbon steel bellows
Outside or auxiliary building air

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Bellows

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pitting corrosion possible outside in presence of moisture, oxygen and acid forming anion such as chloride	Oxygen, impurities
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Medium	Medium	Medium	Conditions for pitting most likely during shutdown. Pitting also follows MIC	Occur especially with oxygen
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	possible if deposits and moisture collect in bellows convolutions; and if outside air contains sufficient contamination	moisture condensing on bellows surfaces
6	Low	Medium	Medium	Bellows are always a potential weak spot	
7	Low	High	Medium	PIT is a potential problem when Cl contamination and wet condition are overlapped.	Any possibility of water moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	

Subgroup **48.14**

Containment Bldg penetrations
Carbon steel bellows
Outside or auxiliary building air

Applies to BNL Part #s with prefix ESF-CONTPEN
Penetration Bellows
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No known external SCC mechanisms if not buried or submerged.	
2	Low	High	High	Well known phenomenon. Unlikely with good practice.	Can occur under the same circumstances as SCC, but contaminants not limited to Cl, not only low temperature phenomenon.
3	Medium	Medium	Medium	Depends on temperature. Ripple loading. High residual stresses. Oxygen, moisture, pitting,	
4	Low	High	High	These are educated "guesses" based on description of system	
5	Medium	High	High	bellows failures common if surfaces can get moist and bellows subject to high residual stress (cold work)	moisture condensing on bellows surfaces
6	Low	Medium	Medium	Bellows are always a potential weak spot	
7	Low	High	High	SCC can potentially happen when contamination and wet condition are overlapped	Any possibility of air moisture condensation?
8	0	High	High	Assumed dry the vast majority of the time	