Proactive Materials Degradation Assessment
BWR Systems

Compilation of Scoring and Comments by Expert Panel

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
FAT-HWC	Fatigue - hydrogen water chemistry
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
SCC-HWC	Stress Corrosion Cracking - hydrogen water chemistry
SW	Swelling
WEAR	Fretting/Wear

Subgroup **1.1**

Pressure Vessel Head Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
8,19,22

Notes: With or without 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading in head / steam environment apparently minor but oxygen content high in principle facilitating corrosion fatigue	Fatigue loading - could be significant in nozzles
3	Low	High	High	Fatigue loading in head / steam environment minor	
4	Low	High	High	Fatigue loading in head / steam environment minor	Environmental effect possible if cladding breached.
5	Low	High	High	Low CUFs, steam environment	
6	Low	High	High	Fatigue loading in head / steam environment minor	Cyclic stresses.
7	Low	High	High	Fatigue loading in head / steam environment minor	
8	Low	High	High	Fatigue loading in head / steam environment minor	

Subgroup **1.1**

Pressure Vessel Head Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
8,19,22

Notes: With or without 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading in head / steam environment apparently minor	Fatigue loading - could be significant in nozzles
3	Low	High	High	Fatigue loading in head / steam environment minor	
4	Low	High	High	Fatigue loading in head / steam environment minor	Environmental effect possible if cladding breached.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	High	High	Fatigue loading in head / steam environment minor	
8	Low	High	Medium	Hydrogen Water chemistry/Noblechem will have little effect in top region	

Subgroup **1.1**

Pressure Vessel Head Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
8,19,22

Notes: With or without 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Almost no relevant data available	
6	Low	High	High	High toughness and low stress under a normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	High	High	High fracture toughness. Steel is clad and defects in clad are not significant.	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. Little FR data in environment	

Subgroup **1.1**

Pressure Vessel Head Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
8,19,22

Notes: With or without 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Medium	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	Most concern would be for any alloy 182 weld pads, which apparently don't exist in these areas	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Generally low stresses and not very aggressive environment. Good service experience.	
6	Medium	High	High	Some cladding crack was experienced in JPDR but didn't propagate into PV head. Need more characterization of the go-no-go condition.	
7	Medium	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas. Assume that steel is clad	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase	Most concern for alloy 182 weld pads which apparently don't exist in these areas

Subgroup **1.1**

Pressure Vessel Head Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
8,19,22

Notes: With or without 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen slightly more favorable than NWC (assuming absence of cladding)	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	Most concern would be for any alloy 182 weld pads, which apparently don't exist in these areas	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	High	High	Lower SCC owing to lower potential	
8	Low	High	Medium	Hydrogen Water chemistry/Noblechem will have little effect in tophead region	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.2

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
9,10,11

Notes: With or without 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fatigue loading in head / steam environment very minor	
2	Low	High	High	Fatigue loading in head / steam environment assumed very minor	Fatigue loading
3	0	High	High	Fatigue loading in head / steam environment very minor	
4	0	High	High	Fatigue loading in head / steam environment very minor.	Environmental effect possible if cladding breached.
5	Low	High	High	Very low CUFs, steam environment	
6	Low	High	High	Fatigue loading in head / steam environment minor	
7	0	High	High	Fatigue loading in head / steam environment very minor	
8	Low	High	High	Fatigue loading in head / steam environment minor	

Group
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Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.2

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
9,10,11

Notes: With or without 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Fatigue loading in head / steam environment very minor	
2	Low	High	High	Fatigue loading in head / steam environment assumed very minor	Fatigue loading
3	0	High	High	Fatigue loading in head / steam environment very minor	
4	0	High	High	Fatigue loading in head / steam environment very minor.	Environmental effect possible if cladding breached.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	High	High	Fatigue loading in head / steam environment minor	
8	Low	High	Medium	Hydrogen Water chemistry/Noblechem will have little effect in top region	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.2

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
9,10,11

Notes: With or without 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and little irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Almost no relevant data available	
6	Low	High	High	High toughness and low stress under a normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Possible defects in such sections	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. Little FR data in environment	

Subgroup **1.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
9,10,11

Notes: With or without 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern in absence of cladding but MnS inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	likely only if surfaces wetted	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Generally low stresses and not very aggressive environment	
6	Medium	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
7	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase	Most concern for alloy 182 weld pads which apparently don't exist in these areas

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.2

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
9,10,11

Notes: With or without 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC (even in absence of cladding) and inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	likely only if surfaces wetted	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	High	High	Lower SCC owing to lower potential	
8	Low	High	Medium	Hydrogen Water chemistry/Noblechem will have little effect in top head region	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.3

RPV Cladding
309 SS 7/32" thick .08%C max.
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
7

Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Has happened - fabrication issue mainly	
3	Low	High	High	Unlikely to occur if not already seen	
4	0	High	High	Not a degradation issue, could provide crevice conditions.	Fabrication issue.
5	Low	Medium	High	May occur occasionally but so what?	Depends on fabrication details not operational variables
6	Low	Medium	Medium	Any consequence into crack of RPV?	Compositional profile cross the fusion boundary
7	Low	High	High	No significant past evidence of debond	
8	Low	High	High	Old problem, now under control via manufacturing control	If it was going to occur in older plant, it would have occurred by now.

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.3

RPV Cladding
309 SS 7/32" thick .08%C max.
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
7

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment very minor	
2	Low	High	High	Fatigue loading in head / steam environment assumed very minor	Fatigue loading
3	Low	High	High	Fatigue loading in head / steam environment very minor	
4	Low	High	High	Fatigue loading in head / steam environment very minor.	
5	Low	Medium	High	Low CUFs, steam environment	
6	Low	High	High	Fatigue loading in head / steam environment very minor	
7	Low	High	High	Fatigue loading in head / steam environment very minor	
8	Low	High	High	Fatigue loading in head / steam environment very minor	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.3

RPV Cladding
309 SS 7/32" thick .08%C max.
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
7

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment very minor	
2	Low	High	High	Fatigue loading in head / steam environment assumed very minor although higher hydrogen less favorable for resistance of austenite to corrosion fatigue	Fatigue loading
3	Low	High	High	Fatigue loading in head / steam environment very minor	
4	Low	High	High	Fatigue loading in head / steam environment very minor.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	High	High	Fatigue loading in head / steam environment very minor	
8	Low	High	High	Hydrogen Water chemistry/Noblechem will have little effect in top head region	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.3

RPV Cladding
309 SS 7/32" thick .08%C max.
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
7

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
2	Low	High	Medium	Some effect of environment on FR may exist but cladding is not considered a structural feature.	
3	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	FR in environment lower than in air?	
6	Low	Medium	Medium	No radiation embrittlement, but some effect of environment on FR may exist. Need to explore and possibility of these crack in clad penetrate into RPV even though it is unlikely.	
7	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
8	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist. Some concern for thermal aging. Little FR data in environment	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.3

RPV Cladding
309 SS 7/32" thick .08%C max.
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
7

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space	
2	Low	High	High	High oxygen a potential concern in absence of cladding but inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space	
4	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space.	Discontinuities in the cladding can act as crevices.
5	Low	High	High	Generally low stresses but conditions are oxidizing	
6	Medium	High	High	Some cladding crack was experienced in JPDR but not into PV head. Need to explore any possibility of these crack penetrate into RPV. Can be common issue in all dissimilar weld and clad.	
7	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space	
8	Medium	High	Medium	Some possibility of SCC due to oxidizing conditions in steam space, but little or no data, hence lower Knowledge score	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.3

RPV Cladding
309 SS 7/32" thick .08%C max.
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
7

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space	
2	Low	High	High	Little risk of SCC given lower oxygen and duplex microstructure	Absence of excessive dilution with base metal and absence of martensite, water quality
3	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space	
4	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space.	Discontinuities in the cladding can act as crevices.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	High	High	Some possibility of SCC due to oxidizing conditions in steam space	
8	Medium	High	Medium	Hydrogen Water chemistry/Noblechem will have little effect in top head region	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.4

Closure Studs, Nuts and Washers
SA 540 Carbon Steel
Containment Air, < 547°F

Applies to BNL Part #s with prefix RPVCH
13,14

Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Could occur by water jet cutting, but considered unlikely	
2	Low	High	High	Steam cutting always possible if head seal leaks	Probability of steam leaks
3	Low	High	High	An issue only if flange leaking	
4	Medium	Medium	Medium	Known issue.	Always possible if flange leaks.
5	Low	High	High	Water jet cutting could occur in the event of a seal leak	
6	Low	High	High	Steam cutting is always possible if head seal leak happens	Flow velocity an pattern are of importance in EC.
7	Low	Medium	Medium	Conditions for EC are not clear and are qualitative	
8	Medium	High	High	Certainly could occur if there was a leak	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.4

Closure Studs, Nuts and Washers
SA 540 Carbon Steel
Containment Air, < 547°F

Applies to BNL Part #s with prefix RPVCH
13,14

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Design issue mainly	Fatigue loading in practice
3	Low	High	High	Fatigue loading expected to be low; likely limited to heatup/cooldown stresses.	Load following?
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	High	Fatigue loading should be low	
6	Low	High	High	No significant fatigue loading sources	Cyclic stresses
7	Low	High	High	Fatigue failures seem to be infrequent if at all. However, this may be a long time low cycle issue.	
8	Low	High	High	Only cyclic loading would be start up/ shut down. Not a problem to date.	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.4

Closure Studs, Nuts and Washers
SA 540 Carbon Steel
Containment Air, < 547°F

Applies to BNL Part #s with prefix RPVCH
13,14

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Hard to imagine enough contact with the environment to cause FR problems	
2	Low	High	High	Toughness included in material selection criteria	Anticipated/unanticipated loading
3	Low	Medium	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	Not aware of any fracture reduction mechanism under these operating conditions.	Environment (air and temperature) and loading conditions not unique - exist in other industries.
5	0	High	High	Don't think there is a mechanism for this in an air environment	
6	Low	High	High	No environment without leak condition to reduce FR. No thermal aging embrittlement within a time of replacement	Thermal aging of these materials on embrittlement.
7	Low	High	High	Good fracture toughness but presence of threads accentuates initial defects	
8	Low	High	High	Well understood degradation mode for replaceable components. Adequate strength specs in place. Little FR data in environment	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.5

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
1,15,17

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming limited fatigue loading	assumes that cladding is breached
2	Low	High	High	Fatigue loading in head / steam environment apparently minor but oxygen content high facilitating corrosion fatigue	Fatigue loading - weld defects
3	Low	High	High	Fatigue loading in head / steam environment very minor	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated.	
5	Low	Medium	High	Low CUFs, steam environment	Cladding must be breached
6	Low	High	High	Fatigue loading in head / steam environment minor	Assumes that cladding is breached.
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	assumes that cladding is breached
8	Low	High	High	Fatigue loading in head / steam environment minor	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.5

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
1,15,17

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Some concern for drop in FR, but concern in this location is limited.	
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	0	High	High	Don't think there is a mechanism for this	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water and LTA	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Fracture toughness of weld region lower; high residual stresses; lever of pipe on vessel	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. Little FR data in environment	

Group **1** **Reactor Coolant System** **Reactor Pressure Vessel Closure Head**

Subgroup **1.5**

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
1,15,17

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Water films form and SCC can form in theory, but service has been excellent and problem species (like Cl) should be very limited.	
2	Low	High	High	High oxygen a potential concern in absence of cladding or if cladding breached/missing	Sulfur content of steel; orientation and shape of sulfide inclusions more favorable than in plates. Assumes clad breached in clad vessels
3	Low	High	High	Unlikely unless highly cold-worked	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Good service experience	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	LTA as well as dynamic strain aging should be considered.
7	Medium	Medium	Medium	SCC prone; residual stresses	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase	Assumes that cladding is breached

Subgroup **1.6**

A533B Plate to Plate Welds
LAS SFA5.5:15-308
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
2,3,4,5

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming limited fatigue loading	assumes that cladding is breached
2	Low	High	High	Fatigue loading in head / steam environment assumed very minor	Fatigue loading - weld defects
3	Low	High	High	Fatigue loading in head / steam environment very minor	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated.	
5	Low	Medium	High	Low CUFs, steam environment	Cladding must be breached
6	Low	High	High	Fatigue loading in head / steam environment minor	Assumes that cladding is breached.
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	assumes that cladding is breached
8	Low	High	High	Fatigue loading in head / steam environment minor	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.6

A533B Plate to Plate Welds
LAS SFA5.5:15-308
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
2,3,4,5

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Some concern for drop in FR, but concern in this location is limited.	
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Concern in this location is limited.	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water and LTA	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Weld fracture resistance is lower and residual stresses higher	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. Little FR data in environment	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.6

A533B Plate to Plate Welds
LAS SFA5.5:15-308
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
2,3,4,5

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Water films form and SCC can form in theory, but service has been excellent and problem species (like Cl) should be very limited.	
2	Low	High	High	High oxygen a potential concern in absence of cladding but inclusion morphology more favorable than in plates	Sulfur content and sulfide inclusion morphology
3	Low	High	High	Unlikely unless highly cold-worked	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Good service experience	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	LTA should be considered.
7	Medium	High	High	High residual stresses, line of higher susceptibility and high residual stresses along welds.	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase	Assumes that cladding is breached

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.7

A508 Nozzle to 304 SS Flange Weld
182 Weld
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
16,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming limited fatigue loading	
2	Low	High	High	Fatigue loading in head / steam environment assumed minor	Fatigue loading - weld defects
3	Low	High	High	Fatigue loading in head / steam environment very minor	
4	0	High	High	Fatigue loading in head / steam environment very minor.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, steam environment	
6	Low	High	High	Fatigue loading due to thermal stress is important in the nozzle.	
7	Low	Medium	Medium	Nozzle to flange has possible lever arm, high residual stresses, possible SCC initiation	
8	Low	High	High	Fatigue loading in head / steam environment minor	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.7

A508 Nozzle to 304 SS Flange Weld
182 Weld
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
16,18

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concerned for FR in 182 because it's high yield strength	
2	Low	High	Medium	Some effect of environment on FR may exist	Transient loads, presence of defects
3	Low	Medium	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	0	High	High	Fully austenitic - toughness not an issue.	
5	Low	Medium	Medium	Not aware of any relevant data	
6	Medium	High	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water.	EAC is one of the concern in terms of J-R resistance due to SCC.
7	Low	Medium	Medium	No cracks but presence of prior defect or SCC would stimulate fracture	
8	Low	High	Medium	Embrittlement due to LTCP (cf PWR) not possible. Hard to define embrittlement mechanism that might apply unless due to weld strain restriction. Little FR data in environment	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.7

A508 Nozzle to 304 SS Flange Weld
182 Weld
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
16,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Water films form and SCC can occur; 182 is quite susceptible to SCC	
2	High	High	High	Significant risk of SCC in oxidizing conditions in steam space in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	Possible if oxidizing conditions exist and/or weld sensitization	
4	Medium	High	High	Some cases reported from steam environment.	May be a function of moisture content of steam.
5	Medium	High	High	Alloy 182 has high SCC susceptibility	
6	Medium	High	High	Surface can be filmed with water and 182 is very susceptible to SCC	182 is the great concerns in science and technology of SCC mechanisms.
7	Medium	Medium	Medium	High residual stresses, lever arm, oxygenated environment.	
8	Medium	Medium	Medium	Very possible in oxidizing environment, but no incidences reported, and no laboratory data	very much dependent on heat treatment and extent of stress relief/sensitization

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.8

304 SS Flange HAZ
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
16,18

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming limited fatigue loading	
2	Low	High	High	Fatigue loading in head / steam environment assumed minor	Fatigue loading
3	Low	High	High	Fatigue loading in head / steam environment very minor	
4	0	High	High	Fatigue loading in head / steam environment very minor.	Environmental effect possible if cladding breached.
5	Low	High	High	Low CUFs, steam environment	
6	Low	High	High	Fatigue loading in head / steam environment minor	Less cyclic stresses
7	Low	High	High	SS less likely to sustain fatigue damage	
8	Low	High	High	Fatigue loading in head / steam environment minor	

Group **1** **Reactor Coolant System** **Reactor Pressure Vessel Closure Head**

Subgroup **1.8** 304 SS Flange HAZ
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
16,18

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concerned for FR in HAZ SS because of high yield strength	
2	Low	High	Medium	Some effect of environment on FR may exist	Transient loads, presence of defects
3	Low	High	Medium	Unlikely at these temperatures and fluences	severe cold work
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Not aware of any relevant data	
6	Medium	High	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	High	High	SS i tough material	
8	Low	High	Medium	Hard to define embrittlement mechanism that might apply, apart from plastic constraint in HAZ. Little FR data in environment	

Subgroup **1.8**

304 SS Flange HAZ
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
16,18

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Water films form and SCC can occur; higher yield strength HAZ-strained SS is susceptible to SCC	
2	High	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	High	Possible if steam oxidizing	
4	Low	High	High	Some cases reported from steam environment in this material (but for less robust components).	
5	Medium	High	High	SS HAZ is well known to be susceptible	
6	Medium	High	High	Surface can be filmed with water and 304 HAZ is susceptible to SCC with weld hardening in HAZ	Stress and microstructure.
7	Medium	High	High	Sensitized SS sustains SCC in oxygenated water	
8	Medium	Medium	Medium	Very possible in oxidizing environment, but no incidences reported, and no laboratory data	very much dependent on heat treatment and extent of stress relief/sensitization

Group **1** **Reactor Coolant System** **Reactor Pressure Vessel Closure Head**

Subgroup **1.9**

Nozzle Flanges
A508 Cl.1
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
20,22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Some concern for drop in FR, but concern in this location is limited.	
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	0	High	High	Don't think there is a mechanism for this material at this location	
6	Low	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	No big leverage nor notches	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. Little FR data in environment	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.9

Nozzle Flanges
A508 Cl.1
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
20,22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Water films form and SCC can form in theory, but service has been excellent and problem species (like Cl) should be very limited.	
2	Medium	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel and orientation of inclusions relative to surface in absence of cladding
3	Low	High	High	Unlikely unless highly cold-worked	
4	Low	High	High	Good experience. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Possible in theory but field experience has been good	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	Less concerns
7	Medium	High	High	Carbon steel sustains SCC in oxygenated water.	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase	Assumes that cladding is breached

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.10

Dryer Hold Down Bracket
304 Stainless Steel
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
24

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Loading, resonances, and possible low potential conditions with NobleChem (giving more rapid CF initiation) need to be understood.	
2	Low	High	High	Fatigue loading in head / steam environment assumed minor	Fatigue loading
3	Low	High	High	can occur if subject to cyclic stresses	
4	Medium	High	High	Fatigue loading probably present and not included in design basis.	
5	Low	Medium	High	Some possibility but I don't know what the EOL CUF's are	
6	Low	High	High	Fatigue loading in head / steam environment minor	
7	Low	Medium	Medium	Lower potential but not negligible	
8	Medium	High	Medium	Increase in susceptibility during power uprate conditions, with ill defined load cycle conditions	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.10

Dryer Hold Down Bracket
304 Stainless Steel
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
24

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Emphasis here is on base metal	
2	Medium	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Low	High	High	Possible if steam oxidized and SS cold-worked or highly stressed	
4	Medium	High	High	Some cases reported from steam environment in this material.	Cold work.
5	Low	High	High	Base metal not very susceptible	
6	Medium	High	High	Surface can be filmed with water and 304 is susceptible to SCC when hardened and under oxidizing environment	Cold work
7	Medium	High	High	SCC of Sens SS in oxygenated water	
8	Medium	High	Medium	Cracking certainly possible in oxidising conditions in condensate. Low knowledge rating indicating little steam data	Cracking observed at Susquehanna-1 in 1985

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.11

Dryer Hold Down Bracket
A533 Gr. B LAS
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
24

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Some concern for drop in FR, but concern in this location is limited.	
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences unless severely cold-worked	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	0	High	High	Don't think there is a mechanism for this material at this location	
6	Low	High	High	There is possible environmental effect on J-R curves but not serious as in 182	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	A tough material but not so tough as SS	
8	Low	High	Medium	Little FR data in environment	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.11

Dryer Hold Down Bracket
A533 Gr. B LAS
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
24

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Water films form and SCC can form in theory, but service has been excellent and problem species (like Cl) should be very limited.	
2	Low	High	High	High oxygen a potential concern but inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface
3	Low	High	High	Unlikely at these temperatures and fluences	severe cold work
4	Low	High	High	Good experience. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Possible in theory but field experience has been good	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
7	Medium	High	High	SCC of steel in oxygenated water	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.12

Dryer Hold Down Bracket Weld
182 Weld
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
23

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Loading, resonances, and possible low potential conditions with NobleChem (giving more rapid CF initiation) need to be understood.	
2	Low	High	High	Fatigue loading in head / steam environment assumed minor	Fatigue loading - weld defects
3	Low	High	High	can occur if subject to cyclic stresses	
4	Low	High	High	Fatigue loading probably present and not included in design basis.	
5	Low	Medium	High	Some possibility but I don't know what the EOL CUF's are	
6	Low	High	High	Fatigue loading due to thermal stress is important in the nozzle.	
7	Low	Medium	Medium	Lower potential but not negligible	
8	Medium	High	Medium	Increase in susceptibility during power uprate conditions, with ill defined load cycle conditions	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.12

Dryer Hold Down Bracket Weld
182 Weld
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
23

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concerned for FR in 182 because it's high yield strength	
2	Low	High	Medium	Some effect of environment on FR may exist	Transient loads, presence of defects
3	Low	Medium	Medium	Unlikely at these temperatures and fluences	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Not aware of any relevant data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water	
7	Medium	Medium	Medium	Fracture toughness possibly low in weld	
8	Low	High	High	Embrittlement due to LTCP (cf PWR) not possible. Hard to define embrittlement mechanism that might apply	

Group
1

Reactor Coolant System

Reactor Pressure Vessel Closure Head

Subgroup
1.12

Dryer Hold Down Bracket Weld
182 Weld
Reactor Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVCH
23

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Water films form and SCC can occur; 182 is quite susceptible to SCC	
2	High	High	High	Significant risk of SCC in oxidizing conditions in steam space in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	Possible if oxidizing conditions exist and/or weld sensitization	
4	Medium	High	High	Some cases reported from steam environment.	May be a function of moisture content of steam.
5	Medium	High	High	Alloy 182 has high SCC susceptibility	
6	Medium	High	High	Surface can be filmed with water and 182 is very susceptible to SCC	Residual stress and microstructure.
7	Medium	Medium	Medium	SCC prone in oxygenated water	
8	Medium	Medium	Low	Very possible in oxidizing environment, but no incidences reported, and no laboratory data	very much dependent on heat treatment and extent of stress relief/sensitization

Group **1** **Reactor Coolant System** **Reactor Pressure Vessel Closure Head**

Subgroup **1.13** Lifting Lug Welds
LAS SFA5.5:15-308
Containment Air

Applies to BNL Part #s with prefix RPVCH
6,12
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	No reason to expect reduced FR in air.	
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	cold work a concern but low temperatures mitigate	
4	0	High	High	No known mechanism, and no environmental effects.	
5	Low	Medium	High	Some possibility of thermal embrittlement of 308 weld metal but effect on FR in air is known to be small	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water and LTA	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	These would not be used often but cannot be connected. Concern here might be with surface defects, weld defects, abusive surface treatments that would provide sites of initiation for FR	
8	Low	High	High	Lugs are stress relieved during manufacture, therefore no localised stresses expected. Unlikely that any fracture resistance reduction in air	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.1**

Pressure Vessel Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam/Water, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
1, 23, 30,39,48,52,61

Notes: With or without 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading considered minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading - could be significant in nozzles
3	Low	High	High	Fatigue loading should be relatively low	high cyclic stresses
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	Cladding must be breached
6	Low	High	High	Fatigue loading in shell/ water environment minor	assumes that cladding is breached
7	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
8	Low	High	High	Fatigue loading in shell minor, but high oxygen in condensed phase for parts 1 and 61 may accelerate environmental effect	assumes that cladding is breached

Subgroup **2.1**

Pressure Vessel Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam/Water, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
1, 23, 30,39,48,52,61

Notes: With or without 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading considered minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor but oxygen probably still high in steam space, which facilitates corrosion fatigue	Fatigue loading - could be significant in nozzles
3	Low	High	High	Fatigue loading should be relatively low	high cyclic stresses
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	High	High	Fatigue loading in head / steam environment minor	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem except for parts 1&61	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.1**

Pressure Vessel Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam/Water, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
1, 23, 30,39,48,52,61

Notes: With or without 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and low level irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences	severe cold work
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	High	High	High toughness and low stress under a normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	High	High	High fracture toughness. Steel is clad and defects in clad are not significant.	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Subgroup **2.1**

Pressure Vessel Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam/Water, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
1, 23, 30,39,48,52,61

Notes: With or without 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for SCC starting in alloy 182 weld pads which exist only in a few areas	
2	Medium	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High		assumes cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Medium	High	High	Some cladding crack was experienced in JPDR but not into PV head	
7	Medium	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas. Assume that steel is clad	
8	Low	High	Medium	No recorded SCC incidences but not a lot of data in steam environments and in particular the effect of partitioning of oxygen to condensed phase for parts 1 and 61	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.1**

Pressure Vessel Flanges and Nozzles
SA 508 Cl.2 Forging
Reactor Coolant Steam/Water, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
1, 23, 30,39,48,52,61

Notes: With or without 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for SCC starting in alloy 182 weld pads which exist only in a few areas	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming absence of cladding)	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	not likely if chemistry reducing	assumes cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	High	High	Low potential solutions	
8	Low	High	Medium	Relatively little effect of HWC/Noblechem for parts 1 & 61i.Susceptibiliy for other parts will be decreased	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.2

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Water, 533-547°F, 1020 psia
Low Neutron dose

Applies to BNL Part #s with prefix RPVSHL
3,9

Notes: With 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	Cladding must be breached
6	Low	High	High	Fatigue loading in shell/ water environment minor	assumes that cladding is breached
7	0	High	High	Fatigue loading in head / steam environment very minor	assumes that cladding is breached
8	Low	High	High	Fatigue loading in shell minor, but high oxygen in condensed phase for parts 3 may accelerate environmental effect	assumes that cladding is breached

Subgroup **2.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Water, 533-547°F, 1020 psia
Low Neutron dose

Applies to BNL Part #s with prefix RPVSHL
3,9

Notes: With 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor and much less significant effects of HWC on corrosion fatigue	Fatigue loading
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	0	High	High	Fatigue loading in head / steam environment very minor	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem except for part 3	

Subgroup **2.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Water, 533-547°F, 1020 psia
Low Neutron dose

Applies to BNL Part #s with prefix RPVSHL
3,9

Notes: With 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and some irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences	severe cold work
4	Low	High	High	Known issue - well documented. Predictive models exist.	Cu and P content.
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	High	High	High toughness and low stress under a normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Possible defects in such sections	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Subgroup **2.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Water, 533-547°F, 1020 psia
Low Neutron dose

Applies to BNL Part #s with prefix RPVSHL
3,9

Notes: With 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern in absence of cladding but inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface if cladding breached
3	Low	High	High		assumes cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
7	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
8	Low	High	High	Good experience, only concern is possible high oxygen content in condensate for part # 3	

Subgroup **2.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Water, 533-547°F, 1020 psia
Low Neutron dose

Applies to BNL Part #s with prefix RPVSHL
3,9

Notes: With 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming absence of cladding) and inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface (if cladding breached)
3	Low	High	High	not likely if chemistry reducing	assumes cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas Also, low potential solutions	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem except for part 3	

Subgroup **2.3**

SA508 Nozzle/Flange to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which high facilitates corrosion fatigue	Fatigue loading
3	Low	High	High	Fatigue loading should be relatively low	high cyclic stresses
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	Cladding must be breached
6	Low	High	High	Fatigue loading in shell/water environment minor	assumes that cladding is breached
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	assumes that cladding is breached
8	Low	High	High	Fatigue loading in shell minor, but high oxygen in condensed phase for parts 2,4,10-12,62 may accelerate environmental effect	assumes that cladding is breached

Subgroup **2.3**

SA508 Nozzle/Flange to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading
3	Low	High	High	Fatigue loading should be relatively low	high cyclic stresses
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem except for parts2,4,10,11,12,62	

Subgroup **2.3**

SA508 Nozzle/Flange to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and low level irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences	
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water and LTA	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Fracture toughness of weld region lower; high residual stresses; lever of pipe on vessel	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Subgroup **2.3**

SA508 Nozzle/Flange to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern if cladding breached/missing	Sulfur content of steel; orientation and shape of sulfide inclusions more favorable than in plates. Assumes clad breached in clad vessels
3	Medium	High	High	Needs oxidizing conditions/sensitization	assumes cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	SCC prone; residual stresses	
8	Low	High	High	Good experience, only concern is possible high oxygen content in condensate for part # 2,4,10-12	

Subgroup **2.3**

SA508 Nozzle/Flange to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming cladding breached/missing)	Sulfur content and sulfide inclusion morphology
3	Medium	High	High	Needs oxidizing conditions/sensitization	assumes cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	Medium	Medium	Lower potential	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem except for parts2,4,10,11,12,62	

Subgroup **2.4**

SA508Nozzle to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
22,60

Notes: Without Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading - could be more significant in nozzle welds
3	Low	High	High	Fatigue loading should be relatively low	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	
6	Low	High	High	Fatigue loading in shell/ water environment minor	
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	
8	Low	High	High	Fatigue loading in shell minor, but high oxygen in condensed phase for parts 60 may accelerate environmental effect	

Subgroup **2.4**

SA508Nozzle to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
22,60

Notes: Without Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading - could be more significant in nozzle welds
3	Low	High	High	Fatigue loading should be relatively low	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem except for part 60	

Subgroup **2.4**

SA508Nozzle to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
22,60

Notes: Without Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and little irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences	
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water and LTA	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Fracture toughness of weld region lower; high residual stresses; lever of pipe on vessel	
8	Low	High	Medium	No FR data in environment	

Subgroup **2.4**

SA508Nozzle to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
22,60

Notes: Without Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel; orientation and shape of sulfide inclusions more favorable than in plates
3	Medium	High	High	Needs oxidizing conditions/sensitization	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	LTA should be considered.
7	Medium	Medium	Medium	SCC prone; residual stresses	
8	Low	High	High	Good experience, only concern is possible high oxygen content in condensate for part # 60	

Subgroup **2.4**

SA508Nozzle to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
22,60

Notes: Without Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC	Sulfur content and sulfide inclusion morphology
3	Medium	High	High	Needs oxidizing conditions/sensitization	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	Medium	Medium	SCC prone; residual stresses; lower potentials	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem except for part 60	

Subgroup **2.5**

SA 533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading - weld defects
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	Cladding must be breached
6	Low	High	High	Fatigue loading in shell/ water environment minor	assumes that cladding is breached
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	assumes that cladding is breached
8	Low	High	High	Fatigue loading in shell minor, but high oxygen in condensed phase for parts 2,4,10-12,62 may accelerate environmental effect	assumes that cladding is breached

Subgroup **2.5**

SA 533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading - weld defects
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem except for parts 2,4,10,11,12,62	

Subgroup **2.5**

SA 533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and little irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	High	Medium	Unlikely at these temperatures and fluences	
4	Low	High	High	Known issue - well documented. Predictive models exist.	Cu and P content.
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water and LTA	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Weld fracture resistance is lower and residual stresses higher	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Subgroup **2.5**

SA 533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern in absence of cladding or if cladding breached/missing	Sulfur content of steel; orientation and shape of sulfide inclusions more favorable than in plates. Assumes clad can be breached in clad vessels
3	Medium	High	High	Needs oxidizing conditions/sensitization	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	LTA should be considered.
7	Medium	High	High	High residual stresses, line of higher susceptibility and high residual stresses along welds.	
8	Low	High	High	Good experience, only concern is possible high oxygen content in condensate for part # 2,4,10-12,62	

Subgroup **2.5**

SA 533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
2,4,,8,10,11,12,16,17,18,19,20,21,29,38,47,51,62

Notes: With 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC	Sulfur content and sulfide inclusion morphology
3	Medium	High	High	Needs oxidizing conditions/sensitization	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Clad cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	High	High	Lower potential	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem except for parts 2,4,10,11,12,62	

Subgroup **2.6**

SA533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia, Beltline
Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
6,13,14,15

Notes: With 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading - weld defects
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	
6	Low	High	High	Fatigue loading in shell/ water environment minor	
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	assumes that cladding is breached
8	Low	High	High	Fatigue loading in shell minor,	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.6

SA533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia, Beltline
Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
6,13,14,15

Notes: With 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading - weld defects
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging. Synergy effects by hydrogen and neutron irradiation would be additional concerns.
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Subgroup **2.6**

SA533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia, Beltline
Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
6,13,14,15

Notes: With 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and some non-negligible irradiation damage. Well characterized and monitored	Presence of defects and transient loads under accident conditions
3	Medium	High	Medium	Possible at higher fluences	
4	Medium	High	High	Known issue - well documented. Predictive models exist.	Cu and P content.
5	Low	Medium	Medium	Radiation embrittlement is well understood but almost no in-environment fracture resistance data are available	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water. Irradiation hardening may reduce the fracture resistance in environment as well as inert environment.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hardening may enhance the reduction in Ji
7	Medium	Medium	Medium	Weld fracture resistance is lower and residual stresses higher. Fracture toughness reduced by irradiation	
8	Medium	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment, Slightly higher Susceptibility score to account for weld defects (which may be considerable)	Neutron embrittlement of LAS addressed in licensing basis and PTS rule

Subgroup **2.6**

SA533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia, Beltline
Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
6,13,14,15

Notes: With 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern if cladding breached but MnS inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Medium	High	High	Needs oxidizing conditions/sensitization	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Medium	High	High	Hardening by irradiation may have an effect on SCC susceptibility.	LTA should be considered.
7	Medium	High	High	High residual stresses, line of higher susceptibility and high residual stresses along welds. SCC accelerated by higher neutron done	
8	Low	High	Medium	Good experience, Effect of irradiation on SCC not fully investigated	

Subgroup **2.6**

SA533 to SA 533 Plate Welds
Reactor Water, 533-547°F, 1020 psia, Beltline
Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
6,13,14,15

Notes: With 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC	Sulfur content and sulfide inclusion morphology
3	Medium	High	High	Needs oxidizing conditions/sensitization	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Clad cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	High	High	High residual stresses, line of higher susceptibility and high residual stresses along welds. SCC accelerated by higher neutron done. lower potential	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.7

SA 533Gr. B Plate
Reactor Water, 533-547°F, 1020 psia
Beltline, Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
5,7

Notes: With 309 SS Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs, good field experience	
6	Low	High	High	Fatigue loading in shell/ water environment minor	
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	assumes that cladding is breached
8	Low	High	High	Fatigue loading in shell minor,	

Subgroup **2.7**

SA 533Gr. B Plate
Reactor Water, 533-547°F, 1020 psia
Beltline, Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
5,7

Notes: With 309 SS Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading in head / steam environment minor	
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading
3	0	High	High	Fatigue loading very minor	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging. Synergy effects by hydrogen and neutron irradiation would be additional concerns.
7	Low	High	High	Fatigue is probably not an issue unless there are dffects in plate welds.	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Subgroup **2.7**

SA 533Gr. B Plate
Reactor Water, 533-547°F, 1020 psia
Beltline, Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
5,7

Notes: With 309 SS Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Almost no data on in-situ fracture resistance	
2	Low	High	High	High toughness and some non-negligible irradiation damage. Well characterized and monitored	Presence of defects and transient loads under accident conditions
3	Medium	High	Medium	Possible at higher fluences	
4	Medium	High	High	Known issue - well documented. Predictive models exist.	Cu and P content.
5	Low	Medium	Medium	Radiation embrittlement is well understood but almost no in-environment fracture resistance data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water. Irradiation hardening may reduce the fracture resistance in environment as well as inert environment.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hardening may enhance the reduction in Ji
7	Medium	Medium	Medium	Weld fracture resistance is lower and residual stresses higher. Fracture toughness reduced by irradiation	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment,	Neutron embrittlement of LAS addressed in licensing basis and PTS rule

Subgroup **2.7**

SA 533Gr. B Plate
Reactor Water, 533-547°F, 1020 psia
Beltline, Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
5,7

Notes: With 309 SS Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	High oxygen a potential concern if cladding breached but MnS inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Medium	High	High	Needs oxidizing conditions/sensitization/cold work	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Not a major concern for low-alloy steels	
6	Medium	High	High	Hardening by irradiation may have an effect on SCC susceptibility.	LTA should be considered.
7	Medium	High	High	High residual stresses, line of higher susceptibility and high residual stresses along welds. SCC accelerated by higher neutron done	
8	Low	High	Medium	Good experience, Effect of irradiation on SCC not fully investigated	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.7**

SA 533Gr. B Plate
Reactor Water, 533-547°F, 1020 psia
Beltline, Higher Neutron Dose
LAS SFA5.5:15-308

Applies to BNL Part #s with prefix RPVSHL
5,7

Notes: With 309 SS Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming absence of cladding) and inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface (if cladding breached)
3	Medium	High	High	Needs oxidizing conditions/sensitization/cold work	assumes that cladding is breached
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term IASCC is not clear yet.	Clad cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	High	High	High residual stresses, line of higher susceptibility and high residual stresses along welds. SCC accelerated by higher neutron done. Lower potential	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.8

Feedwater Safeend
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
25,26,32,50,54(LPCI)

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Possible if thermal cyclic stresses present	bypass flow leakage
4	Low	High	Medium	Good field experience. Lack of specific lab data, but can probably use wrought austenitic data.	
5	Low	Medium	Medium	Good field experience	
6	Low	High	High	Good field experience	
7	Medium	High	High	Fatigue accentuated because of possible lever	
8	Medium	High	High	Can crack, but covered in design basis	Very much dependent on design of thermal sleeve.

Subgroup **2.8**

Feedwater Safeend
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
25,26,32,50,54(LPCI)

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Could be some concern for CF initiation with NobleChem in higher yield strength HAZ	
2	Low	Medium	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	Possible if thermal cyclic stresses present	bypass flow leakage
4	Low	High	Medium	Good field experience. Lack of specific lab data, but can probably use wrought austenitic data.	
5	Low	Medium	Medium	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in alloy 600.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging in alloy 600.
7	Medium	High	High	Fatigue accentuated because of possible lever	
8	Low	High	Medium	Maybe mitigated but very dependent on loading conditions	

Subgroup **2.8**

Feedwater Safeend
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
25,26,32,50,54(LPCI)

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
2	Low	Medium	Medium	Possible effect of HWC on fracture resistance, especially if sensitized	Presence of defects and transient loads under accident conditions
3	Medium	Medium	Medium	some concern in HWC	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	LTCP effect is small for Alloy 600 but there are almost no in-environment fracture resistance data	
6	Low	High	High	Only theoretical concerns.	No monotonic rising load.
7	0	Medium	Medium	Tough material. No radiation.	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **2.8**

Feedwater Safeend
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
25,26,32,50,54(LPCI)

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	If creviced, SCC occurs fairly readily	
2	High	High	High	Weld HAZ potentially vulnerable in NWC if sensitized	Sensitization, cold work, residual stress
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	SCC can occur fairly readily if creviced	
6	Medium	High	High	SCC can tale place under this condition and can be accelerated by cold work and some cyclic stress overlapped on constant load	Hardening by fabrication, processes and machining is a critical in SCC initiation and propagation.
7	Medium	High	High	Alloy 600 SCC accelerated in oxygenated water but somewhat slow owing to lower temperature.	
8	Medium	High	High	Has cracked in service , effectively mitigated by crevice design	

Subgroup **2.8**

Feedwater Safeend
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
25,26,32,50,54(LPCI)

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	If creviced, SCC occurs fairly readily	
2	Medium	High	High	Weld HAZ less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Cold work, residual stress, water quality
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 600
7	Low	High	High	Low potential solutions minimizes SCC	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.9**

Feedwater Thermal Sleeve
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Thermal mixing stresses	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism.	
5	Low	High	High	Thermal cycling likely	
6	Medium	High	High	Many field experiences due to thermal fatigue	Thermal fatigue
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Medium	High	High	Can crack, but covered in design basis	Very much dependent on design of thermal sleeve.

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.9**

Feedwater Thermal Sleeve
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
27

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Could be some concern for CF initiation with NobleChem in higher yield strength HAZ	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	Thermal mixing stresses	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in alloy 600.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging in alloy 600.
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Low	High	Medium	Maybe mitigated but very dependent on loading conditions	

Subgroup **2.9**

Feedwater Thermal Sleeve
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	If creviced, SCC occurs fairly readily	
2	High	High	High	Potentially vulnerable in NWC if sensitized or cold worked	Sensitization, cold work, residual stress
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	SCC can occur fairly readily if creviced	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	Hardening by fabrication, processes and machining is a critical in SCC initiation and propagation.
7	Medium	High	High	Alloy 600 SCC accelerated in oxygenated water but somewhat slow owing to lower temperature.	
8	Medium	High	High	Has cracked in service , effectively mitigated by crevice design	

Subgroup **2.9**

Feedwater Thermal Sleeve
Inconel 600
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
27

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	If creviced, SCC occurs fairly readily. Low potential might not easily be achieved here.	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Cold work, residual stress, water quality
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 600
7	Low	High	High	Low potential	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.10**

Feedwater Thermal Sleeve/A508 Nozzle Weld
Dissimilar 182 Weld
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Crevice aids SCC initiation, but crevice corrosion itself is not an issue	
2	Low	High	High	Potential threat in crevice between sleeve and nozzle, especially in NWC	Water quality
3	Low	Medium	Medium	needs tight crevice geometry and oxygenated water	
4	Low	High	High	Crevice exists, although impurity concentrations should not be sufficiently high to initiate SCC.	
5	0	High	High	Crevice aids SCC initiation, but crevice corrosion itself is not an issue	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	
7	Medium	Medium	Medium	Presence of oxygen accentuates crevice corrosion	
8	Low	High	High	Very dependent on crevice geometry. Not likely to be a major problem at current coolant purity levels	

Subgroup **2.10**

Feedwater Thermal Sleeve/A508 Nozzle Weld
Dissimilar 182 Weld
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading considered minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Thermal mixing stresses	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism.	
5	Low	High	High	Thermal cycling possible	
6	Medium	High	High	Many field experiences due to thermal fatigue	Thermal fatigue
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Low	High	High	Can crack, but covered in design basis	

Subgroup **2.10**

Feedwater Thermal Sleeve/A508 Nozzle Weld
Dissimilar 182 Weld
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading considered minor	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	Thermal mixing stresses	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment	
6	Medium	Medium	Medium	Role of hydrogen under thermal fatigue condition is not clear.	Frequency and hydrogen effects are critical.
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Low	High	Medium	Maybe mitigated but very dependent on loading conditions	

Subgroup **2.10**

Feedwater Thermal Sleeve/A508 Nozzle Weld
Dissimilar 182 Weld
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	FR is a larger issue in higher yield strength materials	
2	Low	Medium	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely at these conditions	hydrogen at low T
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data but Alloy 182 is susceptible to LTCP in PWR environments	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hardening may enhance the reduction in Ji
7	Low	Medium	Medium	Lower FR but proneness depends on stress intensity conditions	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **2.10**

Feedwater Thermal Sleeve/A508 Nozzle Weld
Dissimilar 182 Weld
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Moderate SCC susceptibility of 182 weld metal	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Known susceptibility	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	Weld strain may increase a hardness in 182 and HAZ.
7	Medium	High	High	Alloy 600 SCC accelerated in oxygenated water but somewhat slow owing to lower temperature. SCC accelerated owing to crevice effects.	
8	Medium	High	High	Well known problem in plant and laboratory	

Subgroup **2.10**

Feedwater Thermal Sleeve/A508 Nozzle Weld
Dissimilar 182 Weld
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assumes low potential is achieved, which might not easy here	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	Medium	High	Assumes ECP can be significantly reduced at this location (which may not be correct)	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 182.
7	Low	High	High	Low potential	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.11**

Nozzle Safeends and Thermal Sleeves
SS 316 including HAZ
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
32,36,58

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assumes limited fatigue loading, but with age, fatigue usage factor may be an issue	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	cyclic stresses from thermal mixing the concern	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism	
5	Low	Medium	High	Moderate CUFs, could be a life-extension issue	Fatigue loading
6	Medium	High	High	Field experience of cracking	Thermal stress and strain arte
7	Low	Medium	Medium	FAT depend on confirguration and local stress intensities	
8	Low	High	High	Generic problem covered in design basis	

Subgroup **2.11**

Nozzle Safeends and Thermal Sleeves
SS 316 including HAZ
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
32,36,58

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assumes limited fatigue loading, but with age, fatigue usage factor may be an issue	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	cyclic stresses from thermal mixing the concern	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment	Fatigue loading
6	Medium	Medium	Medium	Hydrogen effects on fatigue for a long term performance is not clear yet	Hydrogen content in metal after a long term exposure in HWC.
7	Low	Medium	Medium	FAT depend on confirguration and local stress intensities	
8	Medium	High	Medium	Concern about increase in fatigue degradation at lower potential (ANL observations) but very dependent on loading conditions	

Subgroup **2.11**

Nozzle Safeends and Thermal Sleeves
SS 316 including HAZ
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
32,36,58

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for HAZ (higher yield strength)	
2	Low	Medium	Medium	Some effect of environment on FR anticipated especially where/if sensitized	Transient loads, presence of defects
3	Medium	Medium	Medium	thermal aging issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Some effect of environment on FR may be possible for sensitized material in HAZ	
6	Low	High	High	Only theoretical concerns.	No monotonic rising load.
7	Medium	Medium	Medium	Lower FR but proneness depends on stress intensity conditions	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **2.11**

Nozzle Safeends and Thermal Sleeves
SS 316 including HAZ
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
32,36,58

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Primary concern for HAZ	
2	High	High	High	Weld HAZ potentially vulnerable in NWC if sensitized or severely cold worked	Stress, stress concentrations, water quality
3	Medium	High	High	oxidizing conditions and stresses, plus susceptible material	
4	Medium	High	Medium	Some failures reported. Lab data exists.	Cold work important factor
5	Medium	High	High	Weld HAZ potentially vulnerable in NWC if sensitized or severely cold worked	Stress, stress concentrations, water quality
6	Medium	High	High	Transition from fatige crack to SCC is not clear yet and likely under some circumstances.	Residual stress and transient stresses
7	Medium	High	High	Oxygenated water and welds and crevices at thermal sleeves.	
8	Medium	High	High	Well recognized problem at HAZ	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.11**

Nozzle Safeends and Thermal Sleeves
SS 316 including HAZ
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
32,36,58

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Larger concern for HAZ	
2	Low	High	High	Stainless steel weld HAZ much less vulnerable in HWC	Stress, stress concentrations, water quality
3	Medium	High	High	HWC assumed ineffective; susceptible material	
4	Medium	High	Medium	Some failures reported. Lab data exists.	Cold work important factor
5	Medium	High	High	Little difference expected between NWC and HWC for this location/environment	Stress, stress concentrations, water quality
6	Medium	Medium	Medium	HWC improve SCC susceptibility by reducing the potential iat the beginning. However, Hydrogen effects on SCC for a long term performance is not clear yet. Hydrogen may accelerate an oxidation rate and may increase SCC susceptibility after hydrogen entry with an enough quantity.	Hydrogen content in metal after a long term exposure in HWC.
7	Low	High	High	Low potential water and welds	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.12**

Dissimilar 82/182 Weld Between Carbon Steel Extension and Alloy 600 Safe end
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24,31,33,35,49,53,55,57

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs cyclic stresses; doesn't seem to be an operating issue	
4	Low	High	Medium	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Thermal expansion coefficient difference is small so fatigue loading probably is not substantial	
6	Medium	Medium	Medium	Slow strain rate may increase FAT susceptibility.	Thermal stress transient is important.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Low	High	High	Can crack, but covered in design basis	

Subgroup **2.12**

Dissimilar 82/182 Weld Between Carbon Steel Extension and Alloy 600 Safe end
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24,31,33,35,49,53,55,57

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs cyclic stresses; doesn't seem to be an operating issue	
4	Low	High	Medium	Possible environmental effects and sensitive component loading. Know of no lab data.	Hydrogen could be detrimental.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.12

Dissimilar 82/182 Weld Between Carbon Steel Extension and Alloy 600 Safe end
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24,31,33,35,49,53,55,57

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR is a larger issue in higher yield strength materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	seems unlikely at these conditions?	hydrogen at low T
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water.	
7	Low	Medium	Medium	Not well defined but larger problem seems to be in lower temperatures	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **2.12**

Dissimilar 82/182 Weld Between Carbon Steel Extension and Alloy 600 Safe end
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24,31,33,35,49,53,55,57

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	182 is a larger concern, but 82 is not immune	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Alloys 182 and 82 are both susceptible	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	
7	Medium	High	High	SCC in oxygenated solutions.	
8	Medium	High	High	Well known problem in plant and laboratory	

Subgroup **2.12**

Dissimilar 82/182 Weld Between Carbon Steel Extension and Alloy 600 Safe end
Reactor Water, 427°F, 1045 psia

Applies to BNL Part #s with prefix RPVSHL
24,31,33,35,49,53,55,57

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	182 is a larger concern, but 82 is not immune	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	SCC likely under these conditions if component stressed or cold worked	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	High	High	Assumes ECP can be significantly reduced at this location (which may not be correct)	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 182.
7	Low	High	High	SCC in low potential solutions.	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.13**

82/182 Weld Pad
Between Clad A508 Nozzle and Alloy 600 Safe End
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
28,37,59

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Crevice aids SCC initiation, but crevice corrosion itself is not an issue	
2	Low	High	High	Potential threat in crevice between thermal sleeve and nozzle	Water quality
3	Low	High	High	oxygenated water	
4	Low	High	High	Crevice exists, although impurity concentrations should not be sufficiently high.	
5	0	High	High	Does inclusion of crevice corrosion add anything here?	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	
7	Medium	Medium	Medium	Crevice problems in oxygenated solutions	
8	Low	High	High	Very dependent on crevice geometry. Not likely to be a major problem at current coolant purity levels	

Subgroup **2.13**

82/182 Weld Pad
Between Clad A508 Nozzle and Alloy 600 Safe End
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
28,37,59

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs cyclic stresses; doesn't seem to be an operating issue	
4	Low	High	Medium	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	Medium	Fatigue loads may be possible	
6	Medium	Medium	Medium	Thermal stress is important during start up and shut-down.	Thermal stress transient is important.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Low	High	High	Can crack, but covered in design basis	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.13

82/182 Weld Pad
Between Clad A508 Nozzle and Alloy 600 Safe End
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
28,37,59

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs cyclic stresses; doesn't seem to be an operating issue	
4	Low	High	Medium	Possible environmental effects and sensitive component loading. Know of no lab data.	Hydrogen could be detrimental.
5	Low	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **2.13**

82/182 Weld Pad
Between Clad A508 Nozzle and Alloy 600 Safe End
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
28,37,59

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR is a larger issue in higher yield strength materials	
2	Low	High	Medium	Some effect of environment on FR may exist	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely at these conditions	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water.	
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.13

82/182 Weld Pad
Between Clad A508 Nozzle and Alloy 600 Safe End
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
28,37,59

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	182 is a larger concern, but 82 is not immune	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	Medium	thermal stress	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Alloys 182 and 82 are both susceptible	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	
7	Medium	Medium	Medium	SCC in weld material but some uncertainties about detailed metallurgical conditions, accelerated by crevice	
8	Medium	High	High	Well known problem in plant and laboratory	

Subgroup **2.13**

82/182 Weld Pad
Between Clad A508 Nozzle and Alloy 600 Safe End
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
28,37,59

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	182 is a larger concern, but 82 is not immune	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	Medium	thermal stress	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	High	High	Assumes ECP can be significantly reduced at this location (which may not be correct)	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 182.
7	Low	Medium	Medium	SCC in weld material but some uncertainties about detailed metallurgical conditions, Low potential water	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.14**

Safe end Extension
Carbon Steel (Unclad)
Reactor Water, <533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
34,56

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed to be small	
2	Low	High	High	Fatigue loading assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading - could be significant near nozzles
3	Low	High	High	needs high cyclic stresses	
4	Low	High	High	Good experience but environment might have en effect.	
5	Low	Medium	High	Low CUFs, good field experience	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	High	Generic problem covered in design basis	

Subgroup **2.14**

Safe end Extension
Carbon Steel (Unclad)
Reactor Water, <533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
34,56

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed to be small	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading - could be significant near nozzles
3	Low	High	High	needs high cyclic stresses	
4	Low	High	High	Good experience but environment might have en effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/material	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **2.14**

Safe end Extension
Carbon Steel (Unclad)
Reactor Water, <533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
34,56

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	FR of a less concern in lower strength materials	
2	Low	High	Medium	Some effect of NWC environment on FR may exist	Transient loads, presence of defects
3	Low	High	High	Requires heavy cold work to be an issue	
4	Low	High	Medium	Possible environmental effects not studied.	
5	Low	Medium	Medium	Almost no relevant data available	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on local stress intensifications	
8	0	High	High	no clear mechanism of embrittlement	

Subgroup **2.14**

Safe end Extension
Carbon Steel (Unclad)
Reactor Water, <533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
34,56

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Minor issue	
2	Low	High	High	Potential threat in poor quality oxygenated water	Water quality
3	Low	High	High	possible if exposure to oxygenated water	
4	Low	Medium	Medium	Cannot be excluded under shut down conditions.	
5	Low	High	High	Some possibility	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	oxygenated	
8	Low	High	High	May occur under shut down, layup and start up conditions when oxygen content is high and temperature low	

Subgroup **2.14**

Safe end Extension
Carbon Steel (Unclad)
Reactor Water, <533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
34,56

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC could be a problem if water chemistry is poor and/or loading transients exist and/or of materials are high S	
2	Medium	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Low	High	High	possible if exposure to oxygenated water	
4	Low	High	High	Good experience, upset chemistry conditions and pitting could be precursors.	Only a problem under specific loading conditions.
5	Low	High	High	Field experience generally good	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	oxygenated, higher temperature	
8	Low	High	High	Unlikely under normal operating conditions unless significant dynamic loading	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.14

Safe end Extension
Carbon Steel (Unclad)
Reactor Water, <533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
34,56

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low potential should mitigate any SCC	
2	Low	High	High	Not a significant risk in HWC	Sulfur content of steel and orientation of inclusions relative to surface
3	Low	High	High	possible if exposure to oxygenated water	
4	Low	High	High	Good experience, upset chemistry conditions and pitting could be precursors.	Only a problem under specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/material	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	low potential higher temperature	
8	Low	High	High	will be largely mitigated by HWC/Noblechem	

Subgroup **2.15**

RPV Cladding, 309 SS
Reactor Water or Coolant Steam
533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
65

Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Might exist in some areas. Should not be a problem in itself, but might promote SCC or CF in the weld dilution zone where composition and hardness are off-nominal.	
2	Low	High	High	Has happened - fabrication issue mainly	
3	Low	High	High	possible if differential thermal expansion causes high enough stresses	
4	0	High	High	Not a degradation issue, could provide crevice conditions	Fabrication issue
5	Low	Medium	Medium	May occur but so what?	Fabrication issue
6	Low	High	High	Possible but not serious consequence	Chemical composition and its gradient at interface.
7	Low	Medium	Medium	No evidence of problems in the field	
8	Low	High	High	Fabrication problem , now under control	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.15

RPV Cladding, 309 SS
Reactor Water or Coolant Steam
533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
65

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	Medium	differential thermal expansion?	
4	Low	Medium	Medium	Good experience.	Effects of environment on duplex steels not known
5	Low	Medium	High	Low CUFs, good field experience	
6	Low	High	High	Fatigue loading is assumed to be not significant	Hardening by thermal aging may affect FAT behavior.
7	Low	High	High	The weld cladding has performed well in service; no fatigue damage	
8	Low	High	High	Generic problem covered in design basis	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.15**

RPV Cladding, 309 SS
Reactor Water or Coolant Steam
533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
65

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading, but HWC could accelerate CF initiation	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	Medium	differential thermal expansion?	
4	Low	Medium	Medium	Good experience.	Effects of environment on duplex steels not known
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	The weld cladding has performed well in service; no fatigue damage	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **2.15**

RPV Cladding, 309 SS
Reactor Water or Coolant Steam
533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
65

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Not likely to be an issue since ferrite level should be below 10 - 12%	
2	Low	High	Medium	Some effect of environment on FR may exist but cladding is not considered a structural feature.	Transient loads, presence of defects
3	Low	Medium	Medium	cold work?	
4	Low	High	Medium	Radiation embrittlement, and some effect of environment on FR may exist.	
5	Low	Medium	Medium	Almost no relevant data available	
6	Low	Medium	Medium	Fracture resistance can be reduced by LTA of delta-ferrite caused by spinodal decomposition.	LTA and hydrogen may have a synergy effects in cracking under a slow monotonic loading condition.
7	Low	Medium	Medium	Good toughness seems to be adequate.	
8	Low	High	Medium	No problems observed to date, but uncertainty about lack of FR data in environment	

Subgroup **2.15**

RPV Cladding, 309 SS
Reactor Water or Coolant Steam
533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC possible, but unlikely	
2	Low	High	High	Little risk of SCC even in oxidizing conditions due to austeno-ferritic microstructure	Absence of excessive dilution with base metal and absence of martensite, water quality
3	Low	High	High	oxygenated water	
4	Low	High	High	Good experience, upset chemistry conditions and pitting could be precursors.	Discontinuities in the cladding can act as crevices.
5	Low	High	High	Field experience has been generally good	
6	Low	High	Medium	SCC in SS weld metal after low temperature aging (LTA) is not clear.	Hardening caused by LTA may increase SCC susceptibility in 309
7	Low	High	High	No SCC observed in weld cladding in oxygenated solutions but the SCC is not immune	
8	Low	High	High	Low susceptibility due to duplex structure, and stress relief after deposition	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.15**

RPV Cladding, 309 SS
Reactor Water or Coolant Steam
533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
65

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC possible, but unlikely	
2	Low	High	High	Little risk of SCC due to austeno-ferritic microstructure and HWC	Absence of excessive dilution with base metal and absence of martensite, water quality
3	Low	High	High	oxygenated water	
4	Low	High	High	Good experience, upset chemistry conditions and pitting could be precursors.	Discontinuities in the cladding can act as crevices.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Hardening and hydrogen may have a synergy effects in SCC	Hydrogen may have some effects on spinodal decomposition. Need to learn from PWR experiences.
7	Low	High	High	No SCC observed in weld cladding in low potential water but the SCC is not immune	
8	Low	Medium	Medium	May be mitigated depending on degree of steam wetness	

Subgroup **2.16**

Main Steam Outlet Nozzle and Safe End
A 508, Carbon Steel
Reactor Coolant Steam, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
61,63

Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Should not be a concern because steam always has O2	
2	Low	Medium	Medium	Risk seems low in oxygenated wet steam	
3	Low	High	High	unlikely unless steam wet	
4	Low	High	High	Not an issue unless high water content in steam.	
5	0	High	High	Not expected to be an issue	
6	Low	High	High	Likely but manageable	
7	Medium	Medium	Medium	oxygen may counter velocity effects	
8	Low	High	High	Unlikely. Danger with increasing steam wetness, decreasing temp, and decreasing oxygen content, but should be well on safe side	0

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.16**

Main Steam Outlet Nozzle and Safe End
A 508, Carbon Steel
Reactor Coolant Steam, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
61,63

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	FR less of a concern in lower strength materials	
2	Low	High	Medium	Some effect of environment on FR may exist	Transient loads, presence of defects
3	Low	High	Medium	possible if component severely cold worked	
4	Low	High	Medium	Possible environmental effects not studied.	
5	Low	Medium	Medium	Almost no relevant data available	
6	Low	High	High	High toughness and low stress under a normal condition.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration; nozzles are heat treated to reduce residual stresses	
8	Low	High	Medium	No problems observed to date, but uncertainty about lack of FR data in environment	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.16

Main Steam Outlet Nozzle and Safe End
A 508, Carbon Steel
Reactor Coolant Steam, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
61,63

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some pitting may develop, including as lower temp is transited, but shouldn't be a big issue	
2	Low	High	High	Potential threat in poor quality oxygenated water	Water quality
3	Low	High	High	unlikely unless steam wet	
4	Low	Medium	Medium	Cannot be excluded under shut down conditions.	
5	Low	High	High	May occur but not likely to be a big deal	
6	Low	High	High	Possible but not serious consequence without initiation of SCC	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated, high flow, prone to pitting	
8	Low	High	High	May occur under shut down, layup and start up conditions when oxygen content is high and temperature low	

Subgroup **2.16**

Main Steam Outlet Nozzle and Safe End
A 508, Carbon Steel
Reactor Coolant Steam, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
61,63

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Liquid films exist on metals in sat'd steam	
2	Medium	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel. Stress
3	Low	High	High	unlikely unless steam wet	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Liquid films exist on metals in sat'd steam but field experience has been good	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	High	High	Oxygenated, high residual stresses	
8	Low	High	High	Unlikely to be a problem unless there is a synergistic effect with FAC and presence of absorbed hydrogen. Still a "long shot"	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.16**

Main Steam Outlet Nozzle and Safe End
A 508, Carbon Steel
Reactor Coolant Steam, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
61,63

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Liquid films exist on metals in sat'd steam	
2	Medium	High	High	Less oxygen but non-negligible in steam space could give significant effect on SCC	Sulfur content of steel and orientation of inclusions relative to surface. Stress
3	Low	High	High	unlikely unless steam wet	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	High	High	Low potential, high residual stresses	
8	Low	High	Medium	Hydrogen Water chemistry/Noblechem will have little effect in main Steam line	

Subgroup **2.17**

Attachment Pads
Alloy 182 on Top of SS Cladding or on RPV
575°F, Reactor Water or Coolant Steam, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
66,67,69,70,72,73,75,76,78,79,80,82,83

Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Might exist in some areas. Should not be a problem in itself, but might promote SCC or CF in the weld dilution zone where composition and hardness are off-nominal.	
2	Low	High	High	Fabrication issue mainly	
3	Low	Medium	Medium	possible, but apparently not common	
4	0	High	High	Not a degradation issue, could provide crevice conditions	Fabrication issue
5	Low	Medium	Medium	May occur but so what?	
6	Low	High	High	Unlikely in plants	Chemical composition and its gradient at interface.
7	Low	Medium	Medium	Seems to be little evidence for debond	
8	Low	High	High	Fabrication problem , now under control	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.17

Attachment Pads
Alloy 182 on Top of SS Cladding or on RPV
575°F, Reactor Water or Coolant Steam, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
66,67,69,70,72,73,75,76,78,79,80,82,83

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if high cyclic stress	
4	Medium	Medium	Medium	Possible environmental and differential expansion effects	
5	Low	Medium	High	Low CUFs, good field experience	
6	Low	High	High	Fatigue loading in head / steam environment minor	
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	High	Generic problem covered in design basis	

Subgroup **2.17**

Attachment Pads
Alloy 182 on Top of SS Cladding or on RPV
575°F, Reactor Water or Coolant Steam, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
66,67,69,70,72,73,75,76,78,79,80,82,83

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	assumes cyclic stresses are present	
4	Medium	Medium	Medium	Possible environmental and differential expansion effects.	
5	Low	Medium	High	Little effect of HWC expected except perhaps for low-frequency loading	
6	Medium	Medium	Medium	Hydrogen effects on fatigue for a long term performance is not clear yet	Hydrogen content in metal after a long term exposure in HWC.
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	High	susceptibility may be reduced in water but not in steam	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.17**

Attachment Pads
Alloy 182 on Top of SS Cladding or on RPV
575°F, Reactor Water or Coolant Steam, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
66,67,69,70,72,73,75,76,78,79,80,82,83

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for higher yield strength materials	
2	Low	High	Medium	Some effect of environment on FR may exist	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely at these conditions	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	In environment test data are lacking	
6	Low	High	High	Possible by environmental effects but no slow rising loading situation.	Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and metallurgy	
8	Low	High	Medium	No problems observed to date, but uncertainty about lack of FR data in environment	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.17**

Attachment Pads
Alloy 182 on Top of SS Cladding or on RPV
575°F, Reactor Water or Coolant Steam, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
66,67,69,70,72,73,75,76,78,79,80,82,83

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	182 is quite susceptible	
2	High	High	High	Significant risk of SCC in oxidizing NWC	Stress, stress concentrations, water quality
3	Medium	High	High	possible if material sensitized or highly stressed	
4	Medium	High	High	Generic issue - field failures and supporting lab data.	Repair welds.
5	Medium	High	High	Known issue, probably mitigated to some extent by HWC	
6	Medium	High	High	Many field experiences of cracking	High residual stress and geometry
7	Medium	Medium	Medium	Oxygenated, prone to SCC	
8	Medium	Medium	Medium	Known plant problem with uncertainty associated with specific fabrication conditions	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.17**

Attachment Pads
Alloy 182 on Top of SS Cladding or on RPV
575°F, Reactor Water or Coolant Steam, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
66,67,69,70,72,73,75,76,78,79,80,82,83

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Borders on a "2" in susceptibility	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	susceptible material and assumes HWC not always effective here	
4	Medium	High	High	Generic issue - field failures and supporting lab data.	
5	Low	High	High	Known issue, probably mitigated to some extent by HWC	
6	Medium	Medium	Medium	HWC improve SCC susceptibility by reducing the potential iat the beginning. However, Hydrogen effects on SCC for a long term performance is not clear yet. Hydrogen may accelerate an oxidation rate and may increase SCC susceptibility after hydrogen entry with an enough quantity.	Hydrogen content in metal after a long term exposure in HWC.
7	Low	Medium	Medium	Oxygenated, prone to SCC	
8	Low	Medium	Medium	susceptibility will be reduced in water but not in steam	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.18

Brackets for Steam Dryer, Guide Rods
CF8M
Reactor Water or Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
68,71, 74,77,81

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Fatigue loading in steam dryer can be significant, esp. with power uprate	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Probably a more vulnerable area than most	Fatigue loading
3	Low	High	High	depends on thermal cycles	
4	Low	Medium	Medium	Possible environmental effects, but no known data.	
5	Medium	High	High	Failures have occurred in steam dryers in some plants following power uprates	
6	Low	High	High	Fatigue loading can be assumed to be small.	Hardening by LTA
7	Low	Medium	Medium	Depends on metallurgy and configuration	
8	Medium	High	High	Fatigue has occurred in some plants, with power uprates	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.18**

Brackets for Steam Dryer, Guide Rods
CF8M
Reactor Water or Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
68,71, 74,77,81

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Fatigue loading in steam dryer can be significant, esp. with power uprate	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue at low frequency. Probably a more vulnerable area than most	Fatigue loading
3	Low	High	High	depends on thermal cycles	
4	Low	Medium	Medium	Possible environmental effects, but no known data.	
5	Medium	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	Synergy effects of hardening and hydrogen is potential concern.	Hardening by LTA
7	Low	Medium	Medium	Depends on metallurgy and configuration	
8	Low	Medium	Medium	Should be decreased with HWC but no effect for parts 68,71	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.18**

Brackets for Steam Dryer, Guide Rods
CF8M
Reactor Water or Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
68,71, 74,77,81

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Concern for aging of cast SS	
2	Medium	High	Medium	Reduced toughness due to thermal aging. Some effect of environment on FR may exist	Thermal aging, transient loads, presence of defects, thermal aging
3	Low	High	Medium	possible if ferrite content too low	
4	Low	High	High	Known issue at higher temperatures.	
5	Medium	High	High	Plentiful data and good predictive models	
6	Medium	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can cause a reduction in fracture resistance and may additional reduction by environments	Hardening is one of the critical factor.
7	Low	Medium	Medium	No brittle incidents but the cast material should have lower toughness	
8	Medium	High	High	Thermal embrittlement of CASS extensively studied(see topical). Lack of FR data in the environment	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.18**

Brackets for Steam Dryer, Guide Rods
CF8M
Reactor Water or Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
68,71, 74,77,81

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Concern for aging of cast SS	
2	Medium	Medium	Low	SCC properties in oxidizing conditions after thermal aging not known	Probably extent of thermal aging
3	Low	High	High	possible if stress high enough	
4	Low	Low	Low	Theoretical concern, but no data.	May depend on ferrite content.
5	Medium	Medium	Medium	Susceptibility could increase with thermal aging	
6	Low	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can increase SCC susceptibility in BWR. No data.	Hardening is one of the critical factor.
7	Low	Medium	Medium	CF8M seems to be resistant to SCC even in oxygenated water although the reason is not clear.	
8	Medium	Medium	Medium	SCC may occur with unknown contribution due to thermal aging	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.18**

Brackets for Steam Dryer, Guide Rods
CF8M
Reactor Water or Coolant Steam, 547°F, 1020 psia

Applies to BNL Part #s with prefix RPVSHL
68,71, 74,77,81

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Concern for aging of cast SS. Note lower score, but low potential may not be achievable here.	
2	Medium	Medium	Low	SCC properties in steam after thermal aging not known; little benefit from HWC anticipated	Probably extent of thermal aging
3	Low	High	High	possible if stress high enough	
4	Low	Low	Low	Theoretical concern, but no data.	May depend on ferrite content.
5	Medium	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Synergy effects of hardening and hydrogen is potential concern.	Hardening by LTA
7	Low	Medium	Medium	Low potential water	
8	Low	Medium	Medium	Should be decreased with HWC but no effect for parts 68,71	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.19

Jet Pump Riser Bracket
304 SS HAZ
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
84

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Probably a more vulnerable area than most	Fatigue loading
3	Low	High	High	depends on thermal cycles	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Low CUFs, good field experience	
6	Medium	Medium	Medium	Ripple loading effects is not clear	Cyclic stresses
7	Low	Medium	Medium	Depends on configuration and local stresses	
8	Low	High	High	Generic problem covered in design basis	

Subgroup **2.19**

Jet Pump Riser Bracket
304 SS HAZ
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
84

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Probably a more vulnerable area than most	Fatigue loading
3	Low	High	High	depends on thermal cycles	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Synergy effects of hardening under ripple stress is not examined and hydrogen is potential concern.	Interaction mechanism between hydrogen mobility and ripple stress.
7	Low	Medium	Medium	Depends on configuration and local stresses	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.19**

Jet Pump Riser Bracket
304 SS HAZ
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
84

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for higher yield strength HAZ	
2	Low	High	Medium	Some effect of environment on FR may exist, especially if sensitized	Transient loads, presence of defects, sensitization
3	Low	Medium	Medium	cold work?	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	In environment test data are lacking	
6	Low	High	High	High toughness and low stress under a normal condition.	Loading rate can be critical.
7	Low	Medium	Medium	Good toughness	
8	Low	High	Medium	No problems observed to date, but uncertainty about lack of FR data in environment	

Group
2

Reactor Coolant System

Reactor Pressure Vessel Shell

Subgroup
2.19

Jet Pump Riser Bracket
304 SS HAZ
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
84

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Moderate SCC susceptibility of HAZ	
2	High	High	High	Risk of SCC in oxidizing conditions depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	Medium	possible if stress high enough	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Medium	High	High	Well-known problem	
6	Medium	High	Medium	Susceptible under these condition and ripple loading effects on SCC is not clear	SCC under dynamic loading condition.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Well recognized problem from 1989 (Monticello, Peach Bottom Quad cities), with strong component of cyclic loading	

Subgroup **2.19**

Jet Pump Riser Bracket
304 SS HAZ
Reactor Water, 533°F, 1059 psia

Applies to BNL Part #s with prefix RPVSHL
84

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HWC will reduce SCC, but cold worked HAZ will show more SCC than base metal	
2	Low	High	High	Risk of SCC much less in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Low	High	High	possible if stress high enough	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Weld hardening may increase SCC susceptibility in hydrogenated water.	
7	Low	High	High	SS in low potential water at reactor temperature	
8	Low	High	High	HWC/Noble chem should be effective	

Subgroup **2.20**

CRD Return Nozzle Cap Weld
LAS SFA5.5:15-308, Not Stress Relieved
Reactor Water, 533°F, 1059 psia (Stagnant)

Applies to BNL Part #s with prefix RPVSHL
39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed minor but oxygen content high, which facilitates corrosion fatigue	Fatigue loading - could be significant near nozzles
3	Medium	High	High	corrosion fatigue possible under oxidizing conditions	
4	0	High	High	Stagnant conditions - should not experience fatigue loading.	
5	Low	Medium	Medium	Low CUF's?	
6	Low	High	High	Fatigue loading is minor.	Fatigue is unlikely.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Low	High	High	Generic problem covered in design basis	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.20**

CRD Return Nozzle Cap Weld
LAS SFA5.5:15-308, Not Stress Relieved
Reactor Water, 533°F, 1059 psia (Stagnant)

Applies to BNL Part #s with prefix RPVSHL
39

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading - could be significant near nozzles
3	Medium	High	High	assumes HWC ineffective	
4	0	High	High	Stagnant conditions - should not experience fatigue loading.	
5	Low	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	Fatigue loading is minor.	Fatigue is unlikely.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **2.20**

CRD Return Nozzle Cap Weld
LAS SFA5.5:15-308, Not Stress Relieved
Reactor Water, 533°F, 1059 psia (Stagnant)

Applies to BNL Part #s with prefix RPVSHL
39

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Some concern for high yield strength (un-stress relieved) weld HAZ	
2	Low	High	Medium	Some effect of NWC environment on FR may exist	Transient loads, presence of defects
4	0	High	High	Stagnant conditions - temperature not high enough for reduction in fracture resistance to be a problem.	
5	Low	Medium	Medium	Almost no in-environment fracture resistance data	
6	Low	High	High	No overloading situation	Hardening is one of the critical factor.
7	Low	Medium	Medium	Not well defined but larger problem seems to be in lower temperatures	
8	Low	High	Medium	No problems observed to date, but uncertainty about lack of FR data in environment	

Group **2** **Reactor Coolant System** **Reactor Pressure Vessel Shell**

Subgroup **2.20**

CRD Return Nozzle Cap Weld
LAS SFA5.5:15-308, Not Stress Relieved
Reactor Water, 533°F, 1059 psia (Stagnant)

Applies to BNL Part #s with prefix RPVSHL
39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Some concern for high yield strength (un-stress relieved) weld HAZ	
2	Medium	High	High	High oxygen a potential concern in absence of cladding	Sulfur content of steel and orientation of inclusions relative to surface in unclad vessel
3	Medium	High	High	possible under oxidizing conditions	
4	0	High	High	Stagnant conditions - should not experience the loading conditions necessary for SCC in this material.	
5	Low	High	High	Not a major concern	
6	Low	Medium	Medium	LAS HAZ may have SCC susceptibility associated with chemical compositional changes(compositional dilution) at weld fusion boundary.	Compositional dilution at fusion boundary can be critical in SCC occurrence.
7	Medium	High	High	SCC in oxygenated solutions.	
8	Low	High	High	SCC of 308 possible but unlikely given duplex structure. Susceptibility at 1 rather than 0 due to non stress relief	

Subgroup **2.20**

CRD Return Nozzle Cap Weld
LAS SFA5.5:15-308, Not Stress Relieved
Reactor Water, 533°F, 1059 psia (Stagnant)

Applies to BNL Part #s with prefix RPVSHL
39

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Low potential will mitigate SCC, but not to zero in untempered material	
2	Medium	High	High	In principle, less risk in HWC if hydrogen can get to this position but in stagnant conditions this does not seem likely	Sulfur content of steel and orientation of inclusions relative to surface
3	Medium	High	High	assumes HWC ineffective	
4	0	High	High	Stagnant conditions - should not experience the loading conditions necessary for SCC in this material.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen is not clear. Need to study.	Hydrogen
7	Low	High	High	SCC in low potential solutions.	
8	Low	High	High	HWC/Noble chem should be effective	

Subgroup **2.21**

Stabilizer Lug Welds
LAS SFA5.5:15-308
Containment Air

Applies to BNL Part #s with prefix RPVSHL
87,88

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Little concern in air	
2	Low	High	High	Toughness depends on normal quality assurance controls of fabrication	Transient loads, presence of defects
3	Low	High	High	can be a concern with high weld stresses/cold work; not known to be a plant issue	
4	0	High	High	No known mechanism, and no environmental effects.	
5	Low	Medium	Medium	Seems unlikely in air environment	
6	Low	High	High	No overloading situation	Hardening is one of the critical factor.
7	Low	Medium	Medium	These would not be used often but cannot be connected. Concern here might be with surface defects, weld defects, abusive surface treatments that would provide sites of initiation for FR	
8	Low	High	High	Lugs are stress relieved during manufacture, therefore no localised stresses expected. Unlikely that any fracture resistance reduction in air	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.1**

Pressure Vessel Head Nozzles
SA 508 Cl.2 Forging
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
15,17,19,21,46

Notes: 309 Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading and usage factors assumed to be small	assumes that cladding is breached
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which high facilitates corrosion fatigue	Fatigue loading - could be significant in nozzles
3	Low	High	High	thermal cycling occurs	assumes that cladding is breached
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Only likely to be an issue for CUFs above 0.1	Cladding must be breached
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stress intensifications	assumes that cladding is breached
8	Low	High	High	Generic problem covered in design basis	assumes that cladding is breached

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.1**

Pressure Vessel Head Nozzles
SA 508 Cl.2 Forging
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
15,17,19,21,46

Notes: 309 Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading and usage factors assumed to be small	assumes that cladding is breached
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading - could be significant in nozzles
3	Low	High	High	thermal cycling occurs	assumes that cladding is breached
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stress intensifications	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.1**

Pressure Vessel Head Nozzles
SA 508 Cl.2 Forging
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
15,17,19,21,46

Notes: 309 Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Absence of FR data measured in environment	
2	Low	High	High	High toughness and little irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	especially if severely cold worked	
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	High toughness and low stress under a normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Good fracture toughness; depends on local stress intensifications	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.1**

Pressure Vessel Head Nozzles
SA 508 Cl.2 Forging
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
15,17,19,21,46

Notes: 309 Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC most likely from 182 attachment pads	
2	Medium	High	High	High oxygen a potential concern if cladding breached	Sulfur content of steel and orientation of inclusions relative to surface
3	Low	High	High	possible in oxidizing chemistry	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Good field experience	
6	Medium	High	High	Some cladding crack was experienced but not into PV head	
7	Medium	Medium	Medium	SCC in oxygenated environments at these temperatures; accentuated by residual stresses.	
8	Low	High	Medium	No recorded SCC incidences. Unresolved effects of water purity and loading transients	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.1**

Pressure Vessel Head Nozzles
SA 508 Cl.2 Forging
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
15,17,19,21,46

Notes: 309 Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC most likely from 182 attachment pads	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming absence of cladding)	Sulfur content of steel and orientation of inclusions relative to surface if clad breached
3	Low	High	High	possible in oxidizing chemistry	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	Medium	Medium	Low potential	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.2

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
2,11,12,13

Notes: 309 Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading and usage factors assumed to be small	assumes that cladding is breached
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which high facilitates corrosion fatigue	Fatigue loading
3	0	High	High	depends on thermal cycling (load following?)	assumes that cladding is breached
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Only likely to be an issue for CUFs above 0.1	Cladding must be breached
6	Low	High	High	Fatigue loading is minor	
7	0	High	High	Fatigue loading in head / steam environment very minor	assumes that cladding is breached
8	Low	High	High	Generic problem covered in design basis	assumes that cladding is breached

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
2,11,12,13

Notes: 309 Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading and usage factors assumed to be small	
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading
3	0	High	High	depends on thermal cycling (load following?)	assumes that cladding is breached
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	0	High	High	Fatigue loading in head / steam environment very minor	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
2,11,12,13

Notes: 309 Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Absence of FR data measured in environment	
2	Low	High	High	High toughness and some low level irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	especially if severely cold worked	
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	High toughness and low stress under a normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Medium	Medium	Medium	Possible defects in such sections	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
2,11,12,13

Notes: 309 Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC most likely from 182 attachment pads	
2	Low	High	High	High oxygen a potential concern if cladding breached but inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface if cladding breached
3	Low	High	High	possible in oxidizing chemistry	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Good field experience	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
7	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	
8	Low	High	Medium	No recorded SCC incidences. Hard to justify any major stress component. Unresolved effects of water purity and loading transients	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.2**

Pressure Vessel Plate
SA-533 Gr.B Rolled Plate
Reactor Coolant 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
2,11,12,13

Notes: 309 Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC most likely from 182 attachment pads	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming absence of cladding) and inclusions not likely to be perpendicular to surface	Sulfur content of steel and orientation of inclusions relative to surface (if cladding breached)
3	Low	High	High	possible in oxidizing chemistry	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	High	High	Less likely but not negligible	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem if it occurred	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.3**

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
1,3,4,5,6,7,8,9,10,14,16,18,20,45

Notes: 309 Cladding

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading and usage factors assumed to be small	assumes that cladding is breached
2	Low	High	High	Fatigue loading is assumed minor but oxygen content high, which high facilitates corrosion fatigue	Fatigue loading
3	Low	High	High	thermal cycling occurs	assumes that cladding is breached
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Low CUFs and good field experience	assumes that cladding is breached
6	Low	High	High	Fatigue loading source is minor.	assumes that cladding is breached
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	assumes that cladding is breached
8	Low	High	High	Generic problem covered in design basis	assumes that cladding is breached

Subgroup **3.3**

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
1,3,4,5,6,7,8,9,10,14,16,18,20,45

Notes: 309 Cladding

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading and usage factors assumed to be small	also include A533B plate to plate welds
2	Low	High	High	Fatigue loading assumed minor; less severe effects of environment on corrosion fatigue in HWC	Fatigue loading
3	Low	High	High	thermal cycling occurs	assumes that cladding is breached
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible if cladding breached.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	also include A533B plate to plate welds
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Stress concentration at joint, residual stresses	also include A533B plate to plate welds
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	also include A533B plate to plate welds

Subgroup **3.3**

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
1,3,4,5,6,7,8,9,10,14,16,18,20,45

Notes: 309 Cladding

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Absence of FR data measured in environment	
2	Low	High	High	High toughness and little irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	especially if severely cold worked	
4	Low	High	Medium	No radiation embrittlement, but some effect of environment on FR may exist.	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Medium	Medium	Medium	Fracture toughness of weld region lower; high residual stresses; lever of pipe on vessel	
8	Low	High	Medium	Slight concern with thermal aging of 309, but likely of small consequence. No FR data in environment	

Subgroup **3.3**

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
1,3,4,5,6,7,8,9,10,14,16,18,20,45

Notes: 309 Cladding

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC most likely from 182 attachment pads	
2	Low	High	High	High oxygen a potential concern if cladding breached/missing but inclusion morphology more favorable than in plates or forgings	Sulfur content of steel; orientation and shape of sulfide inclusions much more favorable than in plates. Assumes clad breached in clad vessels
3	Low	High	High	possible in oxidizing chemistry	
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Good field experience	
6	Low	High	High	Most concern for alloy 182 weld pads which apparently don't exist in these areas	LTA should be considered.
7	Medium	Medium	Medium	SCC prone; residual stresses	
8	Low	High	Medium	No recorded SCC incidences. Unresolved effects of water purity and loading transients	

Subgroup **3.3**

SA508 Nozzle to SA 533 Plate Welds
LAS SFA5.5:15-308
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
1,3,4,5,6,7,8,9,10,14,16,18,20,45

Notes: 309 Cladding

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC most likely from 182 attachment pads	
2	Low	High	High	Lower oxygen more favorable than NWC (assuming cladding breached/missing)	Sulfur content and sulfide inclusion morphology
3	Low	High	High	possible in oxidizing chemistry	also include A533B plate to plate welds
4	Low	High	High	Good experience, theoretical risk if cladding penetrated. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Role of hydrogen in metals
7	Low	Medium	Medium	SCC prone; residual stresses, low potential	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem if it occurred	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.4**

Dissimilar Metal Weld 182/82
508 Nozzle to 316L Safe End
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
22

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading - could be significant at bimetallic welds near nozzles
3	Low	High	High	thermal cycling occurs	
4	Low	High	Medium	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	Medium	Low anticipated fatigue loads	
6	Medium	Medium	Medium	Thermal fatigue would be a potential source of fatigue	Quantification of thermal stress during a transitional condition.
7	Low	Medium	Medium	Depends on configuration and residual stresses	
8	Low	High	High	Generic problem covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.4

Dissimilar Metal Weld 182/82
508 Nozzle to 316L Safe End
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
22

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading - could be significant at bimetallic welds near nozzles
3	Low	High	High	thermal cycling occurs	
4	Low	High	Medium	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen under thermal fatigue condition is not clear.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Depends on configuration and residual stresses	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **3.4**

Dissimilar Metal Weld 182/82
508 Nozzle to 316L Safe End
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
22

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR needs quantification in-situ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	not a big issue here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	SCC can take place during fracture resistance measurement. Dynamic loading is critical to accelerate SCC under a monotonic rising load.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **3.4**

Dissimilar Metal Weld 182/82
508 Nozzle to 316L Safe End
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Clear susceptibility of 182	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	possible in oxidizing chemistry	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Alloys 182 and 82 are both susceptible	
6	Medium	High	High	One o f the most concerns	
7	Medium	High	High	SCC in oxygenated solutions.	
8	Medium	High	High	Well known problem in plant and laboratory	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.4**

Dissimilar Metal Weld 182/82
508 Nozzle to 316L Safe End
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
22

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HWC helps but won't fully stop SCC	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	possible in oxidizing chemistry	HWC effective?
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may accelerate SCC after long term exposure to HWC
7	Low	High	High	Low potential	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem if it occurred. Question of degree of mitigation at low potential is the reason for "1" rather than"0"	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.5**

Dissimilar Metal Weld 182/82
J-weld Incore and CRD Penetrations
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
28A,28B,28C,30A,30B,30C

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading - could be significant at bimetallic J-welds
3	Low	High	High	thermal cycling occurs	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	Medium	Medium	Thermal fatigue would be a potential source of fatigue	Quantification of thermal stress during a transitional condition.
7	Low	Medium	Medium	Depends on configuration and residual stresses	
8	Low	High	High	Can crack, but covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.5

Dissimilar Metal Weld 182/82
J-weld Incore and CRD Penetrations
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
28A,28B,28C,30A,30B,30C

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading - could be significant at bimetallic J-welds
3	Low	High	High	thermal cycling occurs	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen under thermal fatigue condition is not clear.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Depends on configuration and residual stresses	
8	Low	High	Medium	Maybe mitigated but very dependent on loading conditions	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.5**

Dissimilar Metal Weld 182/82
J-weld Incore and CRD Penetrations
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
28A,28B,28C,30A,30B,30C

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Primary concern for HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	not a big issue here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	SCC can take place during fracture resistance measurement. Dynamic loading is critical to accelerate SCC under a monotonic rising load.
7	Low	Medium	Medium	Lowered fracture toughness at weld but depends on stresses and configuration	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.5

Dissimilar Metal Weld 182/82
J-weld Incore and CRD Penetrations
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
28A,28B,28C,30A,30B,30C

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Primary concern for HAZ	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	a concern in oxidizing chemistry	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Weld HAZ is main concern	
6	Medium	High	High	One o f the most concerns. High susceptibility and many field experiences	
7	Medium	High	High	SCC in oxygenated solutions.	
8	Medium	High	High	Well known problem in plant and laboratory	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.5**

Dissimilar Metal Weld 182/82
J-weld Incore and CRD Penetrations
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
28A,28B,28C,30A,30B,30C

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Primary concern for HAZ	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	a concern in oxidizing chemistry	HWC may not be effective?
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may accelerate SCC after long term exposure to HWC
7	Low	High	High	Low potential	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem . Question of degree of mitigation at low potential is the reason for "1" rather than"0"	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.6

Safe End and Thermal Sleeve
316NG or 316L SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23,24,25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading - could be significant at bimetallic welds near nozzles
3	Low	High	High	thermal cycling occurs	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	Medium	Medium	Thermal stress is important during start up and shut-down.	Environmental effects will be significant under low strain rate conditions.
7	Low	Medium	Medium	FAT depend on configuration and local stress intensities	
8	Low	High	High	Generic problem covered in design basis	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.6**

Safe End and Thermal Sleeve
316NG or 316L SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23,24,25

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading - could be significant at bimetallic welds near nozzles
3	Low	High	High	thermal cycling occurs	
4	Medium	High	Medium	Numerous failures due to thermal fatigue, a non material specific degradation mechanism.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	SS 316 is less sensitive to hydrogen but need more qualification on hydrogen effects in Fatigue.	Less hydrogen susceptibility than Ni base alloys
7	Low	Medium	Medium	FAT depend on configuration and local stress intensities	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.6**

Safe End and Thermal Sleeve
316NG or 316L SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23,24,25

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Primary concern for HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	Only theoretical concerns.	No monotonic rising load.
7	Low	Medium	Medium	Depends on configuration and local stress intensifications	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.6

Safe End and Thermal Sleeve
316NG or 316L SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23,24,25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Primary concern for HAZ	
2	Medium	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	High	plant failures reported	
4	Medium	High	Medium	Some failures reported. Lab data exists.	Cold work and welding process important factors.
5	Medium	High	High	Weld HAZ is main concern	
6	Medium	High	Medium	Thermal stress is important during start up and shut-down.	Environmental effects will be significant under low strain rate conditions.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Well recognized problem at HAZ, somewhat lessened by L-grade	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.6

Safe End and Thermal Sleeve
316NG or 316L SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23,24,25

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Primary concern for HAZ	
2	Low	High	High	Weld HAZ less much vulnerable in HWC	Stress, stress concentrations, water quality
3	0	High	High	unlikely here	
4	Medium	High	Medium	Some failures reported. Lab data exists.	Cold work and welding process important factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	SS 316 is less sensitive to hydrogen but need more qualification on hydrogen effects in Fatigue.	Less hydrogen susceptibility than Ni base alloys
7	Low	High	High	Low potential and crevice effects minimized.	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem .	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.7

Safe End
304 SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	thermal cycling occurs	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	Medium	Medium	Thermal stress is important during start up and shut-down.	Environmental effects will be significant under low strain rate conditions.
7	Low	Medium	Medium	FAT depend on configuration and local stress intensities	
8	Low	High	High	Can crack, but covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.7

Safe End
304 SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	thermal cycling occurs	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	SS 316 is less sensitive to hydrogen but need more qualification on hydrogen effects in Fatigue.	Less hydrogen susceptibility than Ni base alloys
7	Low	Medium	Medium	FAT depend on configuration and local stress intensities	
8	0	High	Medium	May be mitigated but very dependent on loading conditions	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.7

Safe End
304 SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Primary concern for HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here?	ferrite probably stays OK
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	High toughness and low stress under a normal condition.	No monotonic rising load.
7	Low	Medium	Medium	Tough material	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.7

Safe End
304 SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Primary concern for HAZ	
2	High	High	High	Risk of SCC in oxidizing conditions depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	High	possible in oxidizing conditions with high stresses	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Medium	High	High	Weld HAZ is main concern	
6	Medium	High	Medium	Thermal stress is important during start up and shut-down.	Environmental effects will be significant under low strain rate conditions.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Well known problem in plant and laboratory. Should be mitigated by good water purity control	

Subgroup **3.7**

Safe End
304 SS HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
23

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Primary concern for HAZ	
2	Low	High	High	Risk of SCC much less than in NWC but also depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	High	possible in oxidizing conditions with high stresses	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	SS 316 is less sensitive to hydrogen but need more qualification on hydrogen effects in Fatigue.	Less hydrogen susceptibility than Ni base alloys
7	Low	High	High	Low potentials	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem .	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.8

308 Weldments
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
24

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	thermal cycling occurs	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Good field experience	
6	Low	High	High	Fatigue loading source is minor.	LTA should be considered.
7	Low	Medium	Medium	More resistant than 304	
8	Low	High	High	Can crack, but covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.8

308 Weldments
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
24

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	thermal cycling occurs	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	Synergy of thermal aging and hydrogen.	Long term behavior is not well characterized.
7	Low	Medium	Medium	More resistant than 304	
8	0	High	Medium	May be mitigated but very dependent on loading conditions	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.8**

308 Weldments
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
24

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Limited ferrite (<10-12%) and yield strength is not high, so little FR concern	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and local defects	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and thermal aging kinetics	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.8**

308 Weldments
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
24

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal susceptible, but SCC is limited	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Low	High	High	high stress and oxidizing conditions a concern	
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal experience generally good	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	High	Susceptibility low due to duplex structure	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.8

308 Weldments
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
24

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low potential should reduce SCC	
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality
3	Low	High	High	high stress and oxidizing conditions a concern	
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Synergy of thermal aging hardening and hydrogen.	Long term behavior is not well characterized.
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem .	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.9** 82/182 Weld Pad Between Thermal Sleeve and Nozzle Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
26

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High		
2	Low	High	High	Potential threat in crevice between thermal sleeve and nozzle, especially in NWC	Water quality
3	Low	High	High	always a concern in oxidizing conditions	
4	Low	High	High	Crevice exists, although impurity concentrations should not be sufficiently high.	
5	0	High	High	I don't think that including CREV here adds much -- SCC is the real concern	
6	Low	High	High	Possible and need to clarify the impact to crack initiation.	Geometries of pad etc.
7	Medium	Medium	Medium	Oxygen accelerates crevice effects	
8	Low	High	High	Very dependent on crevice geometry. Not likely to be a major problem at current coolant purity levels	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.9

82/182 Weld Pad Between
Thermal Sleeve and Nozzle
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	susceptible if cycled	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	Medium	Medium	Slow strain rate may increase FAT susceptibility.	Thermal stress transient is important.
7	Low	Medium	Medium	Depends on configuration	
8	Low	High	Medium	mechanical and thermal cyclic loading , but hard to analyse	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.9** 82/182 Weld Pad Between Thermal Sleeve and Nozzle Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
26

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	susceptible if cycled	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Depends on configuration	
8	0	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **3.9**

82/182 Weld Pad Between
Thermal Sleeve and Nozzle
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
26

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for all high yield strength materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	82/182 is susceptible to SCC and results in reduction of J-R curves
7	Low	Medium	Medium	Depends on configuration and metallurgy	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.9** 82/182 Weld Pad Between Thermal Sleeve and Nozzle Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
26
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	182 is a known problem	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	likely sensitized and thus susceptible (182)	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Alloys 182 and 82 both are susceptible	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	High residual stress and susceptible microstructure.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Well known problem in laboratory	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.9** 82/182 Weld Pad Between Thermal Sleeve and Nozzle Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
26

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC in 182 will be lower at low potential, but may still be significant	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	likely sensitized and thus susceptible (182)	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 82/182.
7	Medium	Medium	Medium	Low potential	
8	Low	High	Medium	Low potential under HWC/Noblechem should mitigate problem . Question of degree of mitigation at low potential reason for "1" rather than"0"	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.10

CRD Stubtube
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	thermal transients, etc. can cause fatigue	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	High	High	Many field experiences due to thermal fatigue	Thermal fatigue
7	Low	Medium	Medium	Not subjected to major fatigue cycles	
8	Low	High	Medium	mechanical and thermal cyclic loading , but hard to analyse	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.10**

CRD Stubtube
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
27
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	thermal transients, etc. can cause fatigue	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in alloy 600.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging in alloy 600.
7	Low	Medium	Medium	Not subjected to major fatigue cycles	
8	0	High	Medium	May be mitigated but very dependent on loading conditions	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.10**

CRD Stubtube
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
27

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for all high yield strength materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	No such a high stress to cause crack in the regime of J-R.	
7	Low	Medium	Medium	Tough material	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.10**

CRD Stubtube
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for HAZ	
2	High	High	High	HAZ potentially very vulnerable in NWC	Sensitization, cold work, residual stress
3	Medium	High	High	likely sensitized	
4	Low	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	Alloy 600 HAZ is fairly easily cracked	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	Hardening by fabrication, processes and machining is a critical in SCC initiation and propagation.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Well known problem in laboratory, but good plant experience	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.10**

CRD Stubtube
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
27

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC in HAZ will be lower at low potential, but may still be significant	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	likely sensitized	
4	Low	High	High	Good field experience and supporting lab data.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 600
7	Low	Medium	Medium	Low potential	
8	Low	High	Medium	Low potential under HWC/Noblechem should mitigate problem . Question of degree of mitigation at low potential reason for "1" rather than"0"	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.11

Dissimilar 82/182 Welds
A533B to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
29,31,35,38,40,43

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	thermal and mechanical cyclic stresses	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	Medium	Medium	Thermal stress is important during start up and shut-down.	Thermal stress transient is important.
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Low	High	High	Can crack, but covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.11

Dissimilar 82/182 Welds
A533B to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
29,31,35,38,40,43

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	thermal and mechanical cyclic stresses	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	0	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **3.11**

Dissimilar 82/182 Welds
A533B to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
29,31,35,38,40,43

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for all high yield strength materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	SCC can take place during fracture resistance measurement. Dynamic loading is critical to accelerate SCC under a monotonic rising load.
7	Low	Medium	Medium	Lower FR but proneness depends on stress intensity conditions	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.11**

Dissimilar 82/182 Welds
A533B to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
29,31,35,38,40,43

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	182 is a known problem	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	always a concern	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Alloys 182 and 82 both are susceptible	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	Residual stress
7	Medium	High	High	SCC accelerated in oxygenated water	
8	Medium	High	High	Well known problem in plant and laboratory	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.11**

Dissimilar 82/182 Welds
A533B to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
29,31,35,38,40,43

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC in 182 will be lower at low potential, but may still be significant	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	always a concern	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 182.
7	Medium	High	High		
8	Low	High	Medium	Low potential under HWC/Noblechem should mitigate problem . Question of degree of mitigation at low potential reason for "1" rather than"0"	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.12**

Alloy 600 (e.g., Shroud Support Leg, Gussets)
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
32, 34,37, 39,41,44

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	thermal and mechanical cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Medium	High	High	Many field experiences due to thermal fatigue	Thermal fatigue
7	Low	Medium	Medium	Depends on configuration and stresses	
8	Low	High	High	Can crack, but covered in design basis	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.12**

Alloy 600 (e.g., Shroud Support Leg, Gussets)
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
32, 34,37, 39,41,44

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	thermal and mechanical cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in alloy 600.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging in alloy 600.
7	Low	Medium	Medium	Depends on configuration and stresses	
8	0	High	Medium	May be mitigated but very dependent on loading conditions	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.12**

Alloy 600 (e.g., Shroud Support Leg, Gussets)
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
32, 34,37, 39,41,44

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for all high yield strength materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	No such a high stress to cause crack in the regime of J-R.	SCC can take place during fracture resistance measurement. Dynamic loading is critical to accelerate SCC under a monotonic rising load.
7	Low	Medium	Medium	Tough material	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.12**

Alloy 600 (e.g., Shroud Support Leg, Gussets)
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
32, 34,37, 39,41,44

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for HAZ	
2	High	High	High	HAZ potentially very vulnerable in NWC	Sensitization, cold work, residual stress
3	Medium	High	High	always a concern	
4	Low	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	Alloy 600 HAZ is fairly easily cracked but HWC should mitigate	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	Hardening by fabrication, processes and machining is a critical in SCC initiation and propagation.
7	High	High	High	Oxygenated	
8	High	High	High	Cracking observed NMP-1 (1995)	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.12**

Alloy 600 (e.g., Shroud Support Leg, Gussets)
Alloy 600 HAZ
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
32, 34,37, 39,41,44

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC in HAZ will be lower at low potential, but may still be significant	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	always a concern	
4	Low	High	High	Good field experience and supporting lab data.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 600
7	Low	Medium	Medium		
8	Low	High	Medium	Low potential under HWC/Noblechem should mitigate problem . Question of degree of mitigation at low potential reason for "1" rather than"0"	

Subgroup **3.13**

182 Weldments of Inconel to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
33,36,42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	thermal and mechanical cyclic stresses	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	High	Medium	Medium	Thermal fatigue is possible source of fatigue and low loading effects on fatigue is important and damaging. Several field experiences	
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Low	High	High	Can crack, but covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.13

182 Weldments of Inconel to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
33,36,42

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	thermal and mechanical cyclic stresses	
4	Low	High	Medium	Possible environmental effects. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in alloy 600.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging in alloy 600.
7	Low	High	High	Fatigue stresses not so high owing to geometry of safe end.	
8	Low	High	Medium	May be mitigated but very dependent on loading conditions	

Subgroup **3.13**

182 Weldments of Inconel to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
33,36,42

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for all high yield strength materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	SCC can take place during fracture resistance measurement. Dynamic loading is critical to accelerate SCC under a monotonic rising load.
7	Low	Medium	Medium	Lower FR but proneness depends on stress intensity conditions	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.13** 182 Weldments of Inconel to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
33,36,42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	182 is a known problem	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	always a concern	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Medium	High	High	Alloys 182 and 82 both are susceptible	
6	High	High	High	One o f the most concerns. High susceptibility and many field experiences	Weld residual stress and susceptible microstructure
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	High	High	High	Access hole cover cracking extensive1998 onwards (PB-2,3 ; QC-1,-2)	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.13**

182 Weldments of Inconel to Inconel
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
33,36,42

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	SCC in 182 will be lower at low potential, but may still be significant	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	always a concern	
4	Medium	High	High	Generic issue - field failures and supporting lab data. Also known external problem in dilution zone with LAS.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 600
7	Low	High	High		
8	Low	High	Medium	Low potential under HWC/Noblechem should mitigate problem . Question of degree of mitigation at low potential reason for "1" rather than"0"	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.14**

Support Skirt
SA533B to A508 Forgings
Containment Air, 533°F

Applies to BNL Part #s with prefix RPVBH
47,48,49,50,51,52,53,54

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stresses	
4	0	High	High	This degradation mechanism was the design basis for the component.	
5	Low	Medium	High	Low anticipated fatigue loads	
6	Low	High	High	No source of cyclic loading.	
7	Low	Medium	Medium	Depends on configuration and stresses	
8	Low	High	High	Can crack, but covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.14

Support Skirt
SA533B to A508 Forgings
Containment Air, 533°F

Applies to BNL Part #s with prefix RPVBH
47,48,49,50,51,52,53,54

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	Medium	Without wetting from leaks, there should be no concern for env. effects, nor concern for FR in air	
2	Low	High	High	No significant in-service degradation of fracture toughness anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	some concern if high stress plus cold worked material	
4	0	High	High	No applicable mechanism.	
5	0	High	High	Not likely in air	
6	0	High	High	No large loading to become a issue	
7	Low	Medium	Medium	Depends on configuration and stresses	
8	Low	High	High		

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.15

Vessel Cladding
309 SS, 0.08%C max
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
55

Notes:

De-bonding

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Might exist in some areas. Should not be a problem in itself, but might promote SCC or CF in the weld dilution zone where composition and hardness are off-nominal.	
2	Low	High	High	Has happened - fabrication issue mainly	
3	Low	High	High	not an issue causing plant problems	if cladding is breached/broken, then SCC, etc. a concern
4	0	High	High	Not a degradation issue, could provide crevice conditions	Fabrication issue
5	Low	Medium	High	May occur occasionally but so what?	Depends on fabrication details not operational variables
6	Low	High	High	Potential problem but no significant consequences.	Compositional gradient and dilution.
7	Low	Low	Low	Good performance. Can't neglect owing to different thermal expansion	
8	Low	Medium	Medium	Should not be problem given current fabrication spec. "2" ratings denote uncertainty in this assumption	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.15

Vessel Cladding
309 SS, 0.08%C max
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
55

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	vessel sees cyclic thermal stresses	
4	Low	Medium	Medium	Good experience.	Effects of environment on duplex steels not known
5	Low	Medium	High	Low anticipated fatigue loads	
6	Low	High	High	Thermal fatigue is a source of cyclic stress but not cause any serious consequences.	LTA is critical.
7	Low	High	High	The weld cladding has performed well in service; no fatigue damage	
8	Low	High	High	Generic problem covered in design basis	

Group
3

Reactor Coolant System

Reactor Pressure Vessel Bottom Head

Subgroup
3.15

Vessel Cladding
309 SS, 0.08%C max
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
55

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume limited fatigue loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	vessel sees cyclic thermal stresses	
4	Low	Medium	Medium	Good experience.	Effects of environment on duplex steels not known
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	Synergy effects of hardening and hydrogen may increase FAT susceptibility	LTA and hydrogen is critical.
7	Low	High	High	The weld cladding has performed well in service; no fatigue damage	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.15**

Vessel Cladding
309 SS, 0.08%C max
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
55

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated but cladding is not considered a structural feature.	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	High	Medium	Radiation embrittlement, and some effect of environment on FR may exist.	
5	Low	Medium	Medium	Lack of FR data measured in environment	
6	Low	High	High	Thermal aging may cause FR by hardening due to Spinodal decomposition of delta ferrite.	LTA is critical.
7	Low	Medium	Medium	Good toughness seems to be adequate.	
8	Low	High	Medium	No problems observed to date, but uncertainty about lack of FR data in environment	

Group **3** **Reactor Coolant System**

Reactor Pressure Vessel Bottom Head

Subgroup **3.15**

Vessel Cladding
309 SS, 0.08%C max
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
55

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Little risk of SCC even in oxidizing conditions due to duplex microstructure	Absence of excessive dilution with base metal and absence of martensite, water quality
3	Low	High	High	needs high stresses and sensitized material	
4	Low	High	High	Some possibility of SCC due to oxidizing conditions.	
5	Low	High	High	Low carbon Type 309 is not very susceptible in lab tests and field experience has generally been good	
6	Medium	High	High	Synergy effects of hardening and environmental effects may increase SCC susceptibility	Hardening by LTA
7	Medium	High	High	No SCC observed in weld cladding in oxygenated solutions but the SCC is not immune	
8	Low	High	High	Low susceptibility due to duplex structure, and stress relief after deposition	

Group **3** **Reactor Coolant System** **Reactor Pressure Vessel Bottom Head**

Subgroup **3.15**

Vessel Cladding
309 SS, 0.08%C max
Reactor Water, 533-547°F, 1020-1059 psia

Applies to BNL Part #s with prefix RPVBH
55

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Little risk of SCC in HWC, especially with duplex microstructure	Absence of excessive dilution with base metal and absence of martensite, water quality
3	Low	High	High	needs high stresses and sensitized material	
4	Low	High	High	Some possibility of SCC due to oxidizing conditions in regions not protected by HWC.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Synergy effects of hardening and hydrogen may increase SCC susceptibility	Hardening by LTA and hydrogen

Subgroup
4.1

Various Ring - Ring Segment Weld Metal - Vertical
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.1

Various Ring - Ring Segment Weld Metal - Vertical
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.1**

Various Ring - Ring Segment Weld Metal - Vertical
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **4.1**

Various Ring - Ring Segment Weld Metal - Vertical
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	High	High	Weld metal is not immune, but is not highly susceptible either	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed tobe better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Low	Medium	Medium	308 is more resistant than 304	
8	Low	High	Medium	SCC resistance is high due to duplex structure, Less knowledge in comparison to e.g.304	

Subgroup **4.1**

Various Ring - Ring Segment Weld Metal - Vertical
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	High	Medium	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	308 is more resistant than 304 but these alloys will still SCC in primary water	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.2

Various Ring - Ring Segment Welds - Vertical HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.2

Various Ring - Ring Segment Welds - Vertical HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.2**

Various Ring - Ring Segment Welds - Vertical HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **4.2**

Various Ring - Ring Segment Welds - Vertical HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	well known SCC system	

Subgroup **4.2**

Various Ring - Ring Segment Welds - Vertical HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
1,5,11
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HAZ has well-demonstrated SCC susceptibility	
2	Low	High	High	Risk of SCC much less in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ and oxidizing conditions	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential but still SCC in low potential water	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.3**

Various Ring - Shell Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.3**

Various Ring - Shell Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.3**

Various Ring - Shell Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **4.3**

Various Ring - Shell Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not immune, but is not highly susceptible either	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	308 is more resistant than 304	
8	Low	High	Medium	SCC resistance is high due to duplex structure, Less knowledge in comparison to e.g.304	

Subgroup **4.3**

Various Ring - Shell Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	High	Medium	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential but can still SCC	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.4**

Various Ring - Shell Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.4**

Various Ring - Shell Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.4**

Various Ring - Shell Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.4

Various Ring - Shell Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	well known SCC system	

Subgroup **4.4**

Various Ring - Shell Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
2,4,6,10,12
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HAZ has well-demonstrated SCC susceptibility	
2	Low	High	High	Much lower risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ and oxidizing conditions	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential but can still SCC	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.5**

Various Shell Plate Vertical Weld Metal
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13
Notes: Low neutron fluence (<0.5 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.5**

Various Shell Plate Vertical Weld Metal
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13
Notes: Low neutron fluence (<0.5 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.5**

Various Shell Plate Vertical Weld Metal
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13
Notes: Low neutron fluence (<0.5 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint and lack of data in environment	

Subgroup **4.5**

Various Shell Plate Vertical Weld Metal
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not immune, but is not highly susceptible either	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed tube better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	308 is more resistant than 304	
8	Low	High	Medium	SCC resistance is high due to duplex structure, Less knowledge in comparison to e.g.304	

Subgroup **4.5**

Various Shell Plate Vertical Weld Metal
Type 308/308L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	High	Medium	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	308 is more resistant than 304, low potential but still prone	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.6**

Various Shell Plate Vertical Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.6**

Various Shell Plate Vertical Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.6**

Various Shell Plate Vertical Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.6**

Various Shell Plate Vertical Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Sensitization is a concern. Depend upon EPR value.	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	High	High	Medium	well known SCC system and cracking at H-1, H-2 welds	

Subgroup **4.6**

Various Shell Plate Vertical Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
3,13

Notes: Low neutron fluence (<0.5 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HAZ has well-demonstrated SCC susceptibility	
2	Low	High	High	Much lower risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs sensitized welds/HAZ and oxidizing conditions	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.7

Various Plate Vertical & Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.7**

Various Plate Vertical & Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.7**

Various Plate Vertical & Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.7**

Various Plate Vertical & Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure but effects of radiation dose unquantified	Water quality, oxidation potential, radiation dose
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	High	High	Weld metal is not immune, but is not highly susceptible either	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed tube better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	308 is more resistant than 304	
8	Low	High	Medium	Duplex SS should be more SCC resistant than 304, but poor data base in irradiation environments	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.7

Various Plate Vertical & Circumferential Weld Metal
Type 308/308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Low	Medium	Medium	Low risk of SCC in HWC due to duplex microstructure but effects of irradiation unquantified	Water quality, oxidation potential, radiation dose
3	Low	High	High	needs sensitized welds/HAZ	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential 308 is more resistant than 304	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.8**

Various Plate Vertical & Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.8**

Various Plate Vertical & Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading/ irradiation increases risk	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	Hydrogen effects can be less in these alloys and HAZ	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.8**

Various Plate Vertical & Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.8**

Various Plate Vertical & Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
2	High	Medium	Medium	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	Medium	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	High	High	Medium	well known SCC system and cracking at H-3, H-4 welds	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.8**

Various Plate Vertical & Circumferential Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
7,8,9

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HAZ has well-demonstrated SCC susceptibility	
2	Medium	Medium	Medium	Lower risk of SCC in HWC but depends on level of radiation dose, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	Medium	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	High	High	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Medium	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.9**

Shell -Shroud Support Ring (H7) Weld Metal
Alloy 182 weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	Irradiation may have a long term effect.
5	Low	Medium	Medium	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.9**

Shell -Shroud Support Ring (H7) Weld Metal
Alloy 182 weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	possible if highly stressed under cyclic loading	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	Irradiation may have a long term effect.
5	Low	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.9**

Shell -Shroud Support Ring (H7) Weld Metal
Alloy 182 weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR in high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	High	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.9**

Shell -Shroud Support Ring (H7) Weld Metal
Alloy 182 weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	Weld metal is not immune, but represents a limited concern.	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	needs sensitized welds/HAZ	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds. Irradiation may have a long term effect.
5	Medium	High	High	Alloy 182 weld metal is susceptible	
6	Medium	High	Medium	Susceptible under these condition and many field experiences	
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Medium	High	High	Hard to inspect weld. Expected to crack by analogy to Access hole covers and laboratory data	

Subgroup **4.9**

Shell -Shroud Support Ring (H7) Weld Metal
Alloy 182 weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not immune, but represents a limited concern.	
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	needs sensitized welds/HAZ	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds. Irradiation may have a long term effect.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.10

Shell -Shroud Support Ring (H7) Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.10**

Shell -Shroud Support Ring (H7) Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	possible if highly stressed under cyclic loading	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.10**

Shell -Shroud Support Ring (H7) Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.10**

Shell -Shroud Support Ring (H7) Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Medium	High	High	Hard to inspect weld. Expected to crack by analogy to Access hole covers and laboratory data	

Subgroup **4.10**

Shell -Shroud Support Ring (H7) Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
14
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	HAZ has well-demonstrated SCC susceptibility	
2	Low	High	High	Much lower risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	needs sensitized welds/HAZ	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.11**

Ring material (segments often forged)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
15,17,20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.11**

Ring material (segments often forged)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
15,17,20

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.11**

Ring material (segments often forged)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
15,17,20

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	forgings may be susceptible depending on ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.11**

Ring material (segments often forged)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
15,17,20

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Forged SS is not immune, but represents a limited concern.	
2	Medium	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs high stress and sensitization	
4	Low	High	High	Good field experience with forged materials.	
5	Low	High	High	Forged material is not immune, but is not highly susceptible either	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Forgings with no obvious microstructure or stress components to drive SCC	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.11

Ring material (segments often forged)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
15,17,20

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Forged SS is not immune, but represents a limited concern.	
2	Low	High	High	Lower risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs high stress and sensitization	
4	Low	High	High	Good field experience with forged materials.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.12

Shell material (segments)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
16,21

Notes: Low neutron fluence (<0.5 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load; seems unlikely here	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.12**

Shell material (segments)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
16,21

Notes: Low neutron fluence (<0.5 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load; seems unlikely here	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was a environmental fatigue component	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.12

Shell material (segments)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
16,21

Notes: Low neutron fluence (<0.5 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely at these low fluences	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.12

Shell material (segments)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
16,21

Notes: Low neutron fluence (<0.5 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Forged SS is not immune, but represents a limited concern.	
2	Medium	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs high stress and sensitization; unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Forged material is not immune, but is not highly susceptible either	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	Medium	well known SCC system and cracking at H-2 welds, but not in parent material	

Subgroup **4.12**

Shell material (segments)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix SHROUD
16,21

Notes: Low neutron fluence (<0.5 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Forged SS is not immune, but represents a limited concern.	
2	Low	High	High	Lower risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs high stress and sensitization; unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.13**

Shell material (segments) - beltline region
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
18,19

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load; seems unlikely here	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.13**

Shell material (segments) - beltline region
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
18,19

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load; seems unlikely here	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.13**

Shell material (segments) - beltline region
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
18,19

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely at these low fluences	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.13**

Shell material (segments) - beltline region
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
18,19

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Forged SS is not immune, but represents a limited concern.	
2	Medium	Medium	Medium	Risk of SCC in oxidizing conditions depends on radiation dose, level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	High	needs high stress and sensitization; unlikely here	
4	Medium	High	Medium	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Forged material is not immune, but is not highly susceptible either	
6	Medium	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	Medium	well known SCC system and cracking at H-2 welds, but not in parent material	

Subgroup **4.13**

Shell material (segments) - beltline region
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate fluence

Applies to BNL Part #s with prefix SHROUD
18,19

Notes: Moderate neutron fluence (0.5 - 3 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Forged SS is not immune, but represents a limited concern.	
2	Medium	Medium	Medium	Lower risk of SCC in HWC but depends on radiation dose, level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	High	needs high stress and sensitization; unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Medium	Medium	Medium	Low potential and residual stresses, SCC accelerated by irradiation	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup
4.14

Miscellaneous brackets, pads, etc. on shroud
Type 304 SS (some/all probably with 308L welds)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
22-42
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	Medium	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.14**

Miscellaneous brackets, pads, etc. on shroud
Type 304 SS (some/all probably with 308L welds)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
22-42
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.14**

Miscellaneous brackets, pads, etc. on shroud
Type 304 SS (some/all probably with 308L welds)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
22-42
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.14**

Miscellaneous brackets, pads, etc. on shroud
Type 304 SS (some/all probably with 308L welds)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
22-42
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	These are presumably welded, and the HAZ has well-demonstrated SCC susceptibility	
2	Medium	Medium	Medium	Risk of SCC in oxidizing conditions, depends on level of cold work, sensitization in HAZ, and water quality	Stress, metallurgical condition, water quality, oxidation potential, sensitization in HAZ
3	Medium	High	High	welded and cold-worked SS susceptible in oxygenated water	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	Weld HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Cracking observed 1978 onwards at various brackets, pads on core shroud and internals	

Subgroup **4.14**

Miscellaneous brackets, pads, etc. on shroud
Type 304 SS (some/all probably with 308L welds)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
22-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	These are presumably welded, and the HAZ has well-demonstrated SCC susceptibility	
2	Low	Medium	Medium	Lower risk of SCC in HWC but depends on level of cold work, sensitization in HAZ, and water quality	Stress, metallurgical condition, water quality, oxidation potential, sensitization in HAZ
3	Low	High	High	unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.15**

Entire top guide structure - interlocked (wedged)
Type 304 SS
Reactor Water (<0.15 mS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate to high fluence

Applies to BNL Part #s with prefix SHROUD
43

Notes: Moderate to high neutron fluence (3 - 10 dpa at end of life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Predicated on low cyclic stress	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.15**

Entire top guide structure - interlocked (wedged)
Type 304 SS
Reactor Water (<0.15 mS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate to high fluence

Applies to BNL Part #s with prefix SHROUD
43

Notes: Moderate to high neutron fluence (3 - 10 dpa at end of life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Predicated on low cyclic stress	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was a fatigue component	

Subgroup **4.15**

Entire top guide structure - interlocked (wedged)
Type 304 SS
Reactor Water (<0.15 mS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate to high fluence

Applies to BNL Part #s with prefix SHROUD
43

Notes: Moderate to high neutron fluence (3 - 10 dpa at end of life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely here, although fluence may have an effect	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.15

Entire top guide structure - interlocked (wedged)
Type 304 SS
Reactor Water (<0.15 mS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate to high fluence

Applies to BNL Part #s with prefix SHROUD
43

Notes: Moderate to high neutron fluence (3 - 10 dpa at end of life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Higher fluence but low stress	
2	High	Medium	Medium	Risk of SCC in oxidizing conditions, depends on level of cold work, radiation dose, and water quality	Stress, stress concentration, metallurgical condition, water quality, oxidation potential, radiation dose
3	Medium	High	High	possible because of end-of-life high fluence	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	Higher fluence but low stress	
6	Medium	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	High	High	Medium	Cracking observed in Top guide (Oyster creek) Question as to source/magnitude of stress	

Subgroup **4.15**

Entire top guide structure - interlocked (wedged)
Type 304 SS
Reactor Water (<0.15 mS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi, moderate to high fluence

Applies to BNL Part #s with prefix SHROUD
43

Notes: Moderate to high neutron fluence (3 - 10 dpa at end of life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Higher fluence but low stress	
2	High	Medium	Medium	Risk of SCC even in HWC depends on level of cold work, radiation dose, and water quality	Stress, stress concentration, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	High	assumes HWC effective in reducing potential	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet. Irradiation also accelerate SCC	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	Medium	Medium	Medium	Low potential and residual stresses, SCC accelerated by irradiation	
8	Low	High	Medium	HWC/Noblechem effective mitigation. Assumes protection potential achieved in water-steam high radiation field	

Subgroup **4.16**

Top guide wedge
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
44

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.16**

Top guide wedge
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
44

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Synergy of irradiation and hydrogen is not clear.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.16

Top guide wedge
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
44

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.16**

Top guide wedge
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
44
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	Risk of SCC in oxidizing conditions, depends on level of cold work, radiation dose, and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	High	possible here because of potentially high stress	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Wrought material is not immune, but is not highly susceptible either	
6	Low	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Wrought material with no obvious microstructure component to drive SCC	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.16

Top guide wedge
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
44

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	Risk of SCC even in HWC in steam space, depends on level of cold work, radiation dose, and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	High	possible here because of potentially high stress	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet. Irradiation also accelerate SCC	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.17

Entire core plate structure
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
45
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.17**

Entire core plate structure
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
45
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if highly stressed under cyclic load	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was a fatigue component	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.17

Entire core plate structure
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
45
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	seems unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.17

Entire core plate structure
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
45
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Uncertain what end of life fluence is, but assume 0.5 - 1 dpa range	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	Uncertain what end of life fluence is, but assume 0.5 - 1 dpa range	
6	Low	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Assume relatively low flux and welded structure	

Subgroup **4.17**

Entire core plate structure
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
45
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Uncertain what end of life fluence is, but assume 0.5 - 1 dpa range	
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet. Irradiation also accelerate SCC	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
4

Reactor Coolant System

Core Shroud

Subgroup
4.18

Core plate bolt assembly
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
46
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	possible if highly stressed under cyclic load; known issue	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.18**

Core plate bolt assembly
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
46
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	possible if highly stressed under cyclic load; known issue	
4	Low	High	High	Good experience. Possible environmental effect.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.18**

Core plate bolt assembly
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
46
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	possible here because of cold work	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels azimuthally and radially	

Subgroup **4.18**

Core plate bolt assembly
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
46
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Should be relatively low fluence	
2	Medium	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Wrought material is not immune, but is not highly susceptible either	
6	Low	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	By analogy to known cracking problem of Core Shroud head bolts (Brunswick 2, 1986) assume that cracking is possible in hard to inspect bottom plate	

Subgroup **4.18**

Core plate bolt assembly
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
46
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Should be relatively low fluence	
2	Medium	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet. Irradiation also accelerate SCC	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup
4.19

Core plate bypass flow plug
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	assumed not to be subject to cyclic stresses	
4	Low	High	High	Fatigue loading should be within design limits.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads expected	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.19**

Core plate bypass flow plug
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	assumed not to be subject to cyclic stresses	
4	Low	High	High	Fatigue loading should be within design limits.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.Base metal will be less sensitive to hydrogen.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Uncertainty due to varying effects of lowered corrosion potential and loading conditions	

Subgroup **4.19**

Core plate bypass flow plug
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	cold work the concern	
4	0	High	High		
5	Low	High	Medium	Little effect of environment on FR anticipated	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Uncetainty in knowledge due to effect of environment on FR	

Group **4** **Reactor Coolant System** **Core Shroud**

Subgroup **4.19**

Core plate bypass flow plug
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work in stainless steels and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	concern only if material severely cold worked	
4	Medium	High	High	Generic problem.	Carbon content and cold work aggrevating factors.
5	Low	High	High	Small risk of SCC assuming absence of sensitization	Stress, metallurgical condition, water quality, ECP
6	Low	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	SCC possible but not likely at good water purity	

Subgroup **4.19**

Core plate bypass flow plug
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Lower risk of SCC in HWC but also depends on level of cold work in stainless steels and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	concern only if material severely cold worked; HWC assumed not consistently effective	
4	Medium	High	High	Generic problem.	Carbon content and cold work aggrevating factors.
5	Low	High	High	Lower risk of SCC in HWC but also depends on level of cold work in stainless steels and water quality	Stress, metallurgical condition, water quality, ECP
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet. Base metal will be less sensitive to hydrogen	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **4.20**

Core plate bypass flow plug
X750 Spring
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	assumed not to be subject to cyclic stresses	
4	Low	High	High	Fatigue loading should be within design limits.	Irradiation may have a long term effect.
5	Low	Medium	High	No significant cyclic loads expected	Fatigue loading
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	High strength should minimize FAT	
8	Low	High	High	No significant fatigue loading	

Subgroup **4.20**

Core plate bypass flow plug
X750 Spring
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	assumed not to be subject to cyclic stresses	
4	Low	High	High	Fatigue loading should be within design limits.	Irradiation may have a long term effect.
5	Low	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	Fatigue loading
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in thiese high strength materials	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	High strength should minimize FAT	
8	Low	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **4.20**

Core plate bypass flow plug
X750 Spring
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR of X750 could be a problem, but these springs may not be a concern	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	concern if incorrectly heat-treated	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	High	Medium	FR of X750 could be a problem	
6	Medium	High	High	Fracture resistance can be reduced by aging a swell as hydrogen effects, depending upon loading condition.	Hydrogen entry and strength. LTA also may decrease FR
7	Medium	High	High	FR if defects; depends on geometry.	
8	Medium	High	Medium	Depends on heat treatment	

Subgroup **4.20**

Core plate bypass flow plug
X750 Spring
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	X750 could be moderately susceptible depending on heat treatment and loading	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on final heat treatment for X750, and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	susceptible material if not carefully heat-treated; highly stressed	
4	Medium	High	High	Dependent on final heat treatment.	Irradiation may have a long term effect.
5	Medium	High	High	X750 is moderately susceptible to SCC in NWC	
6	Medium	High	High	Less susceptible than 304 SS HAZ but hardening may increase susceptibility	
7	High	High	High	This alloy is crack prone	
8	Medium	High	High	Depends on heat treatment	

Subgroup **4.20**

Core plate bypass flow plug
X750 Spring
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix SHROUD
47
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	X750 could be moderately susceptible depending on heat treatment and loading	
2	Medium	High	High	Lower risk of SCC in HWC but depends on final heat treatment for X750, and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	susceptible material if not correctly heat-treated; highly stressed; HWC assumed not consistently effective	
4	Medium	High	High	Dependent on final heat treatment.	Irradiation may have a long term effect.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	LTA may increase SCC susceptibility in X750 based upon Lab.Data. Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	High	High	High	This alloy is crack prone; problem at low potentials also	
8	Low	High	Medium	HWC/Noblechem should offer effective mitigation	

Subgroup
5.1

Fuel Support Structure
Wrought or Cast SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
2
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if high cyclic stress present	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading can be assumed to be small.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.1**

Fuel Support Structure
Wrought or Cast SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
2
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if high cyclic stress present	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	LTA hardening of vast SS may increase FAT susceptibility	Spinodal decomposition and hardening
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.1**

Fuel Support Structure
Wrought or Cast SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
2

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	More concern for aged cast SS	
2	Medium	Medium	Medium	Some effect of environment on FR anticipated, also thermal aging in cast SS	Transient loads, presence of defects, thermal aging
3	Low	Medium	Medium	ferrite content a concern with cast or cold worked material	
4	Low	Medium	Medium	Depending on ferrite content could be a potential problem for cast material.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	More concern for thermally aged cast SS	
6	Medium	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can cause a reduction in fracture resistance and may additional reduction by environments	Hardening is one of the critical factor.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern for thermal aging of CASS and effect of environment on FR value	

Subgroup **5.1**

Fuel Support Structure
Wrought or Cast SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
2
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	More concern for aged cast SS	
2	Medium	Medium	Low	Risk of SCC in oxidizing conditions, depends on level of cold work, thermal aging in cast SS, and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	Medium	high fluence at end of life?	
4	Low	High	High	Good field experience.	
5	Low	High	High	More concern for thermally aged cast SS	
6	Low	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can increase SCC susceptibility in BWR. No data.	Hardening
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Uncertain as to extent of stress. Duplex structure relatively resistant	

Subgroup **5.1**

Fuel Support Structure
Wrought or Cast SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
2
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Low	Low risk of SCC for wrought SS, probably higher for thermally aged CASS in HWC, depends on level of cold work, degree of thermal aging in CASS, and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	Medium	high fluence at end of life?	
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Synergy effects of hydrogen and thermal aging is not clear yet.	Hardening
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
5

Reactor Coolant System

Core Control

Subgroup
5.2

Control Rod Blade
304/316 Stainless Steel, often chemistry controls
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, 4-6 dpa

Applies to BNL Part #s with prefix CORECTRL
4

Notes: Can achieve ~4 - 6 dpa, variable with duty

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	Medium	possible if high cyclic stresses present	
4	0	--	--	Replaceable component no known fatigue loading.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	No cyclic stress	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.2**

Control Rod Blade
304/316 Stainless Steel, often chemistry controls
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, 4-6 dpa

Applies to BNL Part #s with prefix CORECTRL
4

Notes: Can achieve ~4 - 6 dpa, variable with duty

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	Medium	possible if high cyclic stresses present	
4	0	--	--	Replaceable component no known fatigue loading.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	No cyclic stress	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.2**

Control Rod Blade
304/316 Stainless Steel, often chemistry controls
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, 4-6 dpa

Applies to BNL Part #s with prefix CORECTRL
4

Notes: Can achieve ~4 - 6 dpa, variable with duty

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	possible risk if high cold work	
4	0	--	--	Replaceable component. Possible problems if not replaced in time.	
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	No external over loading to cause cracking.	Unlikely scenario
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Subgroup **5.2**

Control Rod Blade
304/316 Stainless Steel, often chemistry controls
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, 4-6 dpa

Applies to BNL Part #s with prefix CORECTRL
4

Notes: Can achieve ~4 - 6 dpa, variable with duty

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	IASCC can occur at low loads	
2	High	Medium	Medium	Risk of SCC in oxidizing conditions, depends on level of cold work, radiation dose, and water quality	Stress, stress concentration, metallurgical condition, water quality, oxidation potential, radiation dose
3	Medium	High	Medium	moderate end-of-life fluences and oxidizing chemistry	
4	0	--	--	Replaceable component, problems reported if not replaced in time.	
5	Medium	High	High	IASCC can occur at low loads	
6	Medium	High	High	Possible occurrence of IASCC and some field experiences.	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Well known IASCC phenomenon since Millstone (1979)	Aggravated by crevices and dynamic loading from B4C swelling

Subgroup **5.2**

Control Rod Blade
304/316 Stainless Steel, often chemistry controls
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, 4-6 dpa

Applies to BNL Part #s with prefix CORECTRL
4

Notes: Can achieve ~4 - 6 dpa, variable with duty

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	High	Medium	Medium	Risk of SCC even in HWC depends on level of cold work, radiation dose, and water quality	Stress, stress concentration, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	Medium	low fluence?	
4	0	--	--	Replaceable component, problems reported if not replaced in time.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen needed to be quantify.	Irradiation effects can be critical.
7	Medium	Medium	Medium	Radiation effects, Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.3**

Control Rod Guide Tube & Housing
CF3 A351
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low to moderate fluence

Applies to BNL Part #s with prefix CORECTRL
3,5
Notes: Top part of guide tube has low-moderate neutron fluence (0.1 - 0.5 dpa at end of its life)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable	Fatigue loading
3	Low	High	High	possible if high cyclic stresses present	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading can be assumed to be small.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.3**

Control Rod Guide Tube & Housing
CF3 A351
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low to moderate fluence

Applies to BNL Part #s with prefix CORECTRL
3,5

Notes: Top part of guide tube has low-moderate neutron fluence (0.1 - 0.5 dpa at end of its life)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if high cyclic stresses present	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Synergy of irradiation and hydrogen is not clear.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.3**

Control Rod Guide Tube & Housing
CF3 A351
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low to moderate fluence

Applies to BNL Part #s with prefix CORECTRL
3,5
Notes: Top part of guide tube has low-moderate neutron fluence (0.1 - 0.5 dpa at end of its life)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Medium	Medium	Medium	Some effect of environment on FR anticipated, also thermal aging in cast SS	Transient loads, presence of defects, thermal aging, radiation dose
3	Medium	Medium	Medium	seems a likely risk, depending on ferrite content	
4	Low	Medium	Medium	Depending on ferrite content could be a potential problem for cast material.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can cause a reduction in fracture resistance and may additional reduction by environments	Hardening is one of the critical factor.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern for thermal aging of CASS and effect of environment on FR value	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.3**

Control Rod Guide Tube & Housing
CF3 A351
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low to moderate fluence

Applies to BNL Part #s with prefix CORECTRL
3,5
Notes: Top part of guide tube has low-moderate neutron fluence (0.1 - 0.5 dpa at end of its life)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Not clear if stresses are sufficient for SCC	
2	Medium	Medium	Low	SCC properties in oxidizing conditions after thermal aging and low neutron dose not known	Probably extent of thermal aging
3	Low	High	High	subject to stress and ferrite content	
4	Low	High	Medium	Good field experience.	Irradiation may have a long term effect.
5	Medium	Medium	High	Not clear if stresses are sufficient for SCC	
6	Low	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can increase SCC susceptibility in BWR. No data.	Hardening is one of the critical factor.
7	Medium	Medium	Medium	SS in oxygenated water at reactor temperature, residual stresses. Much less background information in cast SS	
8	Medium	High	Medium	IGSCC in CRDM housing (part 5) in early plants (1975) due to thermal stresses and poor water chemistry from CST. Largely overcome by redesign	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.3**

Control Rod Guide Tube & Housing
CF3 A351
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low to moderate fluence

Applies to BNL Part #s with prefix CORECTRL
3,5
Notes: Top part of guide tube has low-moderate neutron fluence (0.1 - 0.5 dpa at end of its life)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Low	SCC properties in HWC after thermal aging and low neutron damage not known	Probably extent of thermal aging
3	Low	High	High	moderate fluences	
4	Low	High	High	Good field experience.	Irradiation may have a long term effect.
5	Low	Medium	High	HWC should help here	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet. Irradiation and LTA hardening also accelerate SCC	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical. Irradiation hardening is also important.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.3**

Control Rod Guide Tube & Housing
CF3 A351
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low to moderate fluence

Applies to BNL Part #s with prefix CORECTRL
3,5
Notes: Top part of guide tube has low-moderate neutron fluence (0.1 - 0.5 dpa at end of its life)

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	Tribo-corrosion can be significant - effect of NWC and HWC not known	Design, thermal hydraulics and water chemistry
3	Low	High	Medium	possible depending on number of insertions	
4	0	--	--	Should not be a problem if correctly aligned.	
5	Low	Medium	Medium	Could be a problem	
6	Low	High	High	Potential degradation mode.	
7	Low	Medium	Medium	This may be worse at low potentials	
8	Low	High	Medium	Not a common mode , but would be a problem if it occurred	Design issue

Group
5

Reactor Coolant System

Core Controls

Subgroup
5.4

Fuel Bundle Alignment Pin
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
6
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume cyclic loading is not significant	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	Medium	possible if high cyclic stresses present	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Assume cyclic loading is not significant	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.4**

Fuel Bundle Alignment Pin
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
6
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	Medium	possible if high cyclic stresses present	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.4**

Fuel Bundle Alignment Pin
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
6
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	possible risk if high cold work	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	Overloading may cause this problem but not a issue under normal condition	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment and effect of fluence (if any at this location)	

Group
5

Reactor Coolant System

Core Controls

Subgroup
5.4

Fuel Bundle Alignment Pin
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
6
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Limited fluence and load; no HAZ	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	Medium	low fluence?	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Limited fluence and load; no HAZ	
6	Medium	High	High	Cold worked SS is sensitive to SCC	LTA should be considered.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	Medium	Medium	Not clear where the stress are originating from. No HAZ. Don't know of any field failures	

Group
5

Reactor Coolant System

Core Controls

Subgroup
5.4

Fuel Bundle Alignment Pin
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
6
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	Medium	low fluence?	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
5

Reactor Coolant System

Core Controls

Subgroup
5.5

Control Rod Drive Housing Flange
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
7
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume cyclic loading is not significant	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	Medium	needs high cyclic stresses	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Assume cyclic loading is not significant	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.5**

Control Rod Drive Housing Flange
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
7
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	Medium	needs high cyclic stresses	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.5**

Control Rod Drive Housing Flange
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
7
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.5**

Control Rod Drive Housing Flange
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
7
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	risk if crevices present	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Limited fluence and load; no HAZ	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	Medium	Medium	Not clear where the stress are originating from. No HAZ. Don't know of any field failures	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.5**

Control Rod Drive Housing Flange
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
7
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	risk if crevices present	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
5

Reactor Coolant System

Core Control

Subgroup
5.6

Control Rod Drive Housing Flange Weld Metal
Type 308/L or 309 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assume cyclic loading is not significant	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Low	High	High	Good field experience.	Know of no fatigue loads.
5	Low	Medium	High	Assume cyclic loading is not significant	
6	Low	High	High	Fatigue loading can be assumed to be small.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.6**

Control Rod Drive Housing Flange Weld Metal
Type 308/L or 309 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Low	High	High	Good field experience.	Know of no fatigue loads.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component. Uncertainty due to lack of data at low temperature	

Subgroup **5.6**

Control Rod Drive Housing Flange Weld Metal
Type 308/L or 309 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	0	High	High	Temperature too low to be a problem	
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can cause a reduction in fracture resistance and may additional reduction by environments. High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment.	

Subgroup **5.6**

Control Rod Drive Housing Flange Weld Metal
Type 308/L or 309 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal not that susceptible to SCC	
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure and low temperature	Water quality, oxidation potential
3	Low	High	High	oxidizing environment and creviced welds a risk, but low temperatures reduce susceptibility	
4	Low	High	High	Unlikely at this low temperature.	
5	Low	High	High	Weld metal not highly susceptible to SCC	
6	Low	High	High	Temperature is low enough to minimize the SCC risk	LTA should be considered.
7	Low	Medium	Medium	Low temperature	
8	Low	High	High	Not likely to be highly susceptible given duplex structure and low temperature. Will be dependent on purity of CST	

Subgroup **5.6**

Control Rod Drive Housing Flange Weld Metal
Type 308/L or 309 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Low risk of SCC in HWC due to duplex microstructure and low temperature	Water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk	assumes HWC effective
4	Low	High	High	Unlikely at this low temperature.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation. Uncertainty due to lack of supporting data at low temperature	

Subgroup **5.7**

Control Rod Drive Housing Flange Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Low	High	High	Good field experience.	Know of no fatigue loads.
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group
5

Reactor Coolant System

Core Control

Subgroup
5.7

Control Rod Drive Housing Flange Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Low	High	High	Good field experience.	Know of no fatigue loads.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component. Uncertainty due to lack of data at low temperature	

Subgroup **5.7**

Control Rod Drive Housing Flange Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	0	High	High	Temperature too low to be a problem	
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment.	

Subgroup **5.7**

Control Rod Drive Housing Flange Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium		
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to low temperature but probably depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	
4	Low	High	High	Unlikely at this low temperature.	
5	Low	High	High	HAZ has well-demonstrated SCC susceptibility at low temperature	
6	Low	High	High	Temperature is low enough to minimize the SCC risk	
7	Low	Medium	Medium	Low temperature	
8	Low	High	High	Likely to be highly susceptible, given low temperature but degree of susceptibility will be dependent on chemistry of CST	

Group
5

Reactor Coolant System

Core Control

Subgroup
5.7

Control Rod Drive Housing Flange Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
105°F, 1059 psi (CRD drive water)

Applies to BNL Part #s with prefix CORECTRL
8
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Lower risk of SCC in HWC and due to low temperature but probably depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	assumes HWC effective
4	Low	High	High	Unlikely at this low temperature.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation. Uncertainty due to lack of supporting data at low temperature	

Subgroup **5.8**

RPV Stub Tube - CRD Housing - upper weld metal
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.8**

RPV Stub Tube - CRD Housing - upper weld metal
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.8**

RPV Stub Tube - CRD Housing - upper weld metal
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment.	

Subgroup **5.8**

RPV Stub Tube - CRD Housing - upper weld metal
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High		
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	oxidizing environment and possible creviced welds a risk/sensitization	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds.
5	Medium	High	High	Alloy 182 is moderately susceptible	
6	Medium	High	Medium	Susceptible under these condition and many field experiences	
7	High	High	High	Alloy 182 in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Known problem in laboratory, and some concern in plant (very hard to inspect)	

Subgroup **5.8**

RPV Stub Tube - CRD Housing - upper weld metal
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	assumes HWC effective
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **5.9**

RPV Stub Tube - CRD Housing - upper weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.9**

RPV Stub Tube - CRD Housing - upper weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.9**

RPV Stub Tube - CRD Housing - upper weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment.	

Subgroup **5.9**

RPV Stub Tube - CRD Housing - upper weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	HAZ has well-demonstrated SCC susceptibility	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	oxidizing environment and possible creviced welds a risk/sensitization	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Known problem in laboratory, and some concern in plant (very hard to inspect)	

Subgroup **5.9**

RPV Stub Tube - CRD Housing - upper weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	assumes HWC effective
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **5.10**

RPV Stub Tube - CRD Housing - upper weld HAZ
Alloy 600 HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	risk if experiences high cyclic loads	
4	Low	High	Medium	Good field experience. Lack of specific lab data, but can probably use wrought austenitic data.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Medium	High	High	Many field experiences due to thermal fatigue	Thermal fatigue
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.10**

RPV Stub Tube - CRD Housing - upper weld HAZ
Alloy 600 HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	risk if experiences high cyclic loads	
4	Low	High	Medium	Good field experience. Lack of specific lab data, but can probably use wrought austenitic data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet in alloy 600.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging in alloy 600.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.10**

RPV Stub Tube - CRD Housing - upper weld HAZ
Alloy 600 HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	No such a high stress to cause crack in the regime of J-R.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment.	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.10**

RPV Stub Tube - CRD Housing - upper weld HAZ
Alloy 600 HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	HAZ has well-demonstrated SCC susceptibility	
2	High	High	High	HAZ potentially very vulnerable in NWC	Sensitization, cold work, residual stress
3	Medium	High	High	oxidizing environment and possible creviced welds a risk/sensitization	
4	Low	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	SCC can take place under these condition and can be accelerated by crack initiation by fatigue to form crevice	Hardening by fabrication, processes and machining is a critical in SCC initiation and propagation.
7	High	High	High	Alloy 600 in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Known problem in laboratory, and some concern in plant (very hard to inspect)	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.10**

RPV Stub Tube - CRD Housing - upper weld HAZ
Alloy 600 HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
9

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, metallurgical condition, water quality
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	assumes HWC effective
4	Low	High	High	Good field experience and supporting lab data.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the precipitation behavior and oxidation kinetics in alloy 600
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.11**

Misc. CRD & Neutron Monitoring - out of core
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
10-16
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.11**

Misc. CRD & Neutron Monitoring - out of core
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
10-16
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.11**

Misc. CRD & Neutron Monitoring - out of core
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
10-16

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment and effect of constraint in these subassemblies.	

Subgroup **5.11**

Misc. CRD & Neutron Monitoring - out of core
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
10-16
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk	
4	Low	High	High	Generic problem.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Wrought material is not immune, but is not highly susceptible either	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Known cracking problem associated with complex residual stresses in these welded structures, often with joints of thick to thin subcomponents	Highly dependent on coolant purity. At the specified coolant conductivity not likely to be a problem, hence the lower susceptibility score

Subgroup **5.11**

Misc. CRD & Neutron Monitoring - out of core
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
10-16
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk	assumes HWC effective
4	Low	High	High	Generic problem.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.12**

In-core Guide Tube Ass. (no delta P across tube)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525-550°F, 1059 psi, high fluence

Applies to BNL Part #s with prefix CORECTRL
17

Notes: High neutron fluence (50-100 dpa)

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No significant fatigue loading	

Subgroup **5.12**

In-core Guide Tube Ass. (no delta P across tube)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525-550°F, 1059 psi, high fluence

Applies to BNL Part #s with prefix CORECTRL
17

Notes: High neutron fluence (50-100 dpa)

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	Medium	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component. Relative lack of data at high fluence	

Subgroup **5.12**

In-core Guide Tube Ass. (no delta P across tube)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525-550°F, 1059 psi, high fluence

Applies to BNL Part #s with prefix CORECTRL
17

Notes: High neutron fluence (50-100 dpa)

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Concern for FR primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	High	High	High toughness and low stress under a normal condition.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of data in environment and effect of constraint in these subassemblies.	

Subgroup **5.12**

In-core Guide Tube Ass. (no delta P across tube)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525-550°F, 1059 psi, high fluence

Applies to BNL Part #s with prefix CORECTRL
17

Notes: High neutron fluence (50-100 dpa)

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for SCC at high fluence even at low stress (e.g., Si effects)	
2	Medium	High	High	Significant risk of SCC of highly irradiated SS in oxidizing conditions despite probable low stress, depends on radiation dose, and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Medium	High	High	oxidizing environment, fluence and possible creviced welds a risk	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	Concern for SCC at high fluence even at low stress (e.g., Si effects)	
6	Medium	High	High	Very high susceptibility caused by neutron fluence, IASCC and also hardening increases susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Known cracking problem from1974 (oyster creek) associated with complex residual stresses in these welded structures, often with joints of thick to thin subcomponents, plus effect of irradiation	Highly dependent on coolant purity and degree of irradiation. The susceptibility rating is high due to irradiation effect perhaps counterbalancing the good water purity specified.

Subgroup **5.12**

In-core Guide Tube Ass. (no delta P across tube)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525-550°F, 1059 psi, high fluence

Applies to BNL Part #s with prefix CORECTRL
17

Notes: High neutron fluence (50-100 dpa)

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Significant risk of SCC of highly irradiated SS even in HWC despite probable low stress, depends on radiation dose, and water quality	Stress, metallurgical condition, water quality, oxidation potential, radiation dose
3	Low	High	High	oxidizing environment, fluence and possible creviced welds a risk	assumes HWC effective
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	Concern for SCC at high fluence even at low stress and with HWC	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	Medium	Low	HWC/Noblechem effective mitigation. Relative lack of data at high fluence	

Group **5** **Reactor Coolant System**

Core Control

Subgroup **5.12**

In-core Guide Tube Ass. (no delta P across tube)
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525-550°F, 1059 psi, high fluence

Applies to BNL Part #s with prefix CORECTRL
17

Notes: High neutron fluence (50-100 dpa)

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	Wear due to flow induced effects seems likely. Tribo-corrosion depends on water chemistry	Flow induced vibration, water chemistry
3	Medium	Medium	Medium	possible if tube contacts other components	
4	0	--	--	Would include in fatigue if flow induced vibrations have effect.	
5	Low	Medium	Medium	Could be a problem	
6	Low	High	High	Flow induced vibration may cause wear.	
7	Low	Medium	Medium	This may be worse at low potentials	
8	Low	High	Medium	Not a common mode , but would be a problem if it occurred	Design issue

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.13** Misc CRD Support Structures - outside vessel
ASTM A36 & A235
Dry
<135°F, Containment Atmosphere

Applies to BNL Part #s with prefix CORECTRL
18-24
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	0	High	High	This degradation mechanism was the design basis for these components.	
5	Low	High	High	Not aware of significant cyclic loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Dry	
8	Low	High	High	No significant fatigue loading	

Group **5** **Reactor Coolant System** **Core Control**

Subgroup **5.13**

Misc CRD Support Structures - outside vessel
ASTM A36 & A235
Dry
<135°F, Containment Atmosphere

Applies to BNL Part #s with prefix CORECTRL
18-24
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High		
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	likely only if contaminants present (nitrates?)	surfaces must be wet at least some of the time
4	Low	High	High	Chloride contamination possible from aerosols. Unlikely with good practice.	
5	Low	High	High	Requires moisture and chloride both of which are most likely during outages or layup	
6	Low	High	High	No significant consequence	
7	0	Medium	Medium	Dry	
8	0	High	High		

Subgroup **5.13**

Misc CRD Support Structures - outside vessel
ASTM A36 & A235
Dry
<135°F, Containment Atmosphere

Applies to BNL Part #s with prefix CORECTRL
18-24
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No SCC if dry; no evidence of external Cl	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	needs wetted surface and/or crevices	
4	Low	High	High	Chloride contamination possible from aerosols. Unlikely with good practice.	
5	0	High	High	No SCC if dry; no evidence of external Cl	
6	0	High	High	No environment	
7	0	Medium	Medium	Dry	
8	0	High	High	No "aggressive " environment. Moist air plus extremely high yield stress may be a possible concern, but these conjoint criteria should be outside possibilities.	

Group
5

Reactor Coolant System

Core Controls

Subgroup
5.14

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS base metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant cyclic loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Uncertain about level of vibratory loading on these structures	

Group **5** **Reactor Coolant System**

Core Controls

Subgroup **5.14**

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS base metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	risk if experiences high cyclic loads	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.14**

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS base metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Wrought material is not immune, but is not highly susceptible either	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	Medium	Medium	Unable to make a judgment based on system description. Certainly 304 SS can be made to crack, but cannot say more	

Subgroup **5.14**

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS base metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk	assumes HWC effective
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **5.15**

Misc DP & Liquid Control Structures - in-vessel
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Fatigue loading can be assumed to be small.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Uncertain about level of vibratory loading on these structures	

Subgroup **5.15**

Misc DP & Liquid Control Structures - in-vessel
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group
5

Reactor Coolant System

Core Control

Subgroup
5.15

Misc DP & Liquid Control Structures - in-vessel
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	Medium	Medium	Spinodal decomposition of delta ferrite after LTA can cause a reduction in fracture resistance and may additional reduction by environments. High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of FR data in environment	

Group **5** **Reactor Coolant System** **Core Controls**

Subgroup **5.15**

Misc DP & Liquid Control Structures - in-vessel
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	Medium	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality, oxidation potential
3	Medium	High	High	oxidizing environment and possible creviced welds a risk	
4	Low	High	High	Good field experience	Irradiation may have a long term effect.
5	Low	High	High	Weld metal is not immune, but is not highly susceptible either	
6	Low	High	High	Temperature is low enough to minimize the SCC risk	LTA should be considered.
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	Medium	Medium	Unable to make a judgment based on system description. Certainly welded 304L SS can crack, but cannot say more	

Subgroup **5.15**

Misc DP & Liquid Control Structures - in-vessel
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk	assumes HWC effective
4	Low	High	High	Good field experience	Irradiation may have a long term effect.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **5.16**

Misc DP & Liquid Control Structures - in-vessel
182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	Irradiation may have a long term effect.
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Uncertain about level of vibratory loading on these structures	

Subgroup **5.16**

Misc DP & Liquid Control Structures - in-vessel
182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	Medium	Medium	issue if high cyclic stresses present	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.16**

Misc DP & Liquid Control Structures - in-vessel
182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of FR data in environment	

Subgroup **5.16**

Misc DP & Liquid Control Structures - in-vessel
182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High		
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	oxidizing environment and possible creviced welds a risk/sensitization	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds. Irradiation may have a long term effect.
5	Medium	High	High	Alloy 182 weld metal is susceptible	
6	Medium	High	Medium	Susceptible under these condition and many field experiences	
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Medium	Medium	Medium		

Subgroup **5.16**

Misc DP & Liquid Control Structures - in-vessel
182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	assumes HWC effective
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds. Irradiation may have a long term effect.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
5

Reactor Coolant System

Subgroup
5.17

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	risk if experiences high cyclic loads	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	Irradiation may have a long term effect.
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Uncertain about level of vibratory loading on these structures	

Subgroup **5.17**

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	risk if experiences high cyclic loads	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	Irradiation may have a long term effect.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **5.17**

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about lack of FR data in environment	

Subgroup
5.17

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	oxidizing environment and possible creviced welds a risk/sensitization	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds. Irradiation may have a long term effect.
5	Medium	High	High	HAZ has well-demonstrated SCC susceptibility	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	Medium	Medium	Unable to make a judgment based on system description. Certainly welded 304 SS will crack, but cannot say more	

Subgroup **5.17**

Misc DP & Liquid Control Structures - in-vessel
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix CORECTRL
25-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and possible creviced welds a risk/sensitization	assumes HWC effective
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds. Irradiation may have a long term effect.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.1

Misc. Pipes & Elbows & JP Mixer/Diffuser
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	possible vibration loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.1**

Misc. Pipes & Elbows & JP Mixer/Diffuser
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.1**

Misc. Pipes & Elbows & JP Mixer/Diffuser
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.1**

Misc. Pipes & Elbows & JP Mixer/Diffuser
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Wrought and forged materials are not highly susceptible	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Wrought material with no obvious microstructure component to drive SCC	

Subgroup **6.1**

Misc. Pipes & Elbows & JP Mixer/Diffuser
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.2

SS-to-SS Welds in above Pipes & Elbows
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	possible vibration loading	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.2

SS-to-SS Welds in above Pipes & Elbows
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.2**

SS-to-SS Welds in above Pipes & Elbows
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and at various fluence levels	

Subgroup **6.2**

SS-to-SS Welds in above Pipes & Elbows
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Medium	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed tube better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	High	Medium	308L relatively immune. Only concern is effect of irradiation for which little data	

Subgroup **6.2**

SS-to-SS Welds in above Pipes & Elbows
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Medium	High	High	HWC effective?	
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.3

SS-to-SS Welds in above Pipes & Elbows (HAZ)
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	possible vibration loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.3**

SS-to-SS Welds in above Pipes & Elbows (HAZ)
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.3

SS-to-SS Welds in above Pipes & Elbows (HAZ)
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.3

SS-to-SS Welds in above Pipes & Elbows (HAZ)
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	HAZ concerns	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	Medium	HAZ concerns	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Known concern with jet pump risers, starting I 1996 (LaSalle, Dresden, etc.)	

Subgroup **6.3**

SS-to-SS Welds in above Pipes & Elbows (HAZ)
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
1-6,8-11,13-16

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.4

Restrainer Bracket Support
XM-19 (Nitronic 50)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
12

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	possible vibration loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.4**

Restrainer Bracket Support
XM-19 (Nitronic 50)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
12

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with cyclic loading
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.4**

Restrainer Bracket Support
XM-19 (Nitronic 50)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
12

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.4**

Restrainer Bracket Support
XM-19 (Nitronic 50)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
12

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unwelded (std YS) XM-19 not very susceptible to SCC	
2	Medium	Medium	Medium	SCC resistance of higher strength materials difficult to judge over long term	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	
4	Low	High	High	Good field experience.	
5	Low	High	High	Unwelded (std YS) XM-19 not very susceptible to SCC	
6	Low	High	High	Most concern for alloy 182 weld which apparently don't exist in these areas	LTA should be considered.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	Medium	Medium	Relatively SCC resistant alloy, but not a lot of data under irradiation conditions	

Subgroup **6.4**

Restrainer Bracket Support
XM-19 (Nitronic 50)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
12

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	SCC resistance of higher strength materials difficult to judge over long term	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem should give effective mitigation. However note relative lack of data for this alloy under these conditions	

Subgroup **6.5**

Jet Pump Holddown Beam
X750 (mostly HTH)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
7

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Some vibration, ripple loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Low	High	High	Good field experience.	
5	Medium	Medium	Medium	Some vibration, ripple loading	
6	Medium	High	High	Ripple stress effects is not characterized in conjunction with SCC	There are some evidences in Labs and field.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	possible vibration loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.5**

Jet Pump Holddown Beam
X750 (mostly HTH)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
7

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Low	High	High	Good field experience.	
5	Medium	Medium	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	High strength alloy may have high susceptibility	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.5**

Jet Pump Holddown Beam
X750 (mostly HTH)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
7

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	High	Medium	known issue in oxidizing environment	
4	Low	Medium	Medium	Could be long term problem, depending on heat treatment. No data.	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Medium	Medium	Medium	Very limited data on FR reduction in environments	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Subgroup **6.5**

Jet Pump Holddown Beam
X750 (mostly HTH)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
7

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High	X750 is moderately susc to SCC, and hold down beam has significant, active stressing	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on final heat treatment for X750, and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	known issue in oxidizing environment	
4	Medium	High	High	Good field experience for HTH, other heat treatments more susceptible.	Heat treatment important, poor inspection techniques can delay detection.
5	Medium	High	High	X750 is moderately susc to SCC, and hold down beam has significant, active stressing	
6	Medium	High	High	Ripple stress effects is not characterized in conjunction with SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Known plant concern (Dresden-3,1980,Clinton 1993, Grand Gulf,1993	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.5

Jet Pump Holddown Beam
X750 (mostly HTH)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
7

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	High	High	High	Risk of SCC even in HWC, depends on final heat treatment for X750, and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	known issue in oxidizing environment	HWC effective?
4	Medium	High	High	Good field experience for HTH, other heat treatments more susceptible.	Heat treatment important, poor inspection techniques can delay detection.
5	Medium	High	High	HWC may help here	
6	Medium	Medium	Medium	Hydrogen effects is not well characterized.	
7	High	High	High	Residual stresses, high strength	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **6.6**

Access Hole Cover (Ledge in Group 4)
Alloy 600 (some covers are SS)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Low	High	Medium	Good field experience. Lack of specific data, can probably use wrought austenitic data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.6**

Access Hole Cover (Ledge in Group 4)
Alloy 600 (some covers are SS)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Low	High	Medium	Good field experience. Lack of specific data, can probably use wrought austenitic data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with cyclic loading
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **6.6**

Access Hole Cover (Ledge in Group 4)
Alloy 600 (some covers are SS)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium		
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition and not so severe as LTC	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Subgroup **6.6**

Access Hole Cover (Ledge in Group 4)
Alloy 600 (some covers are SS)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	SCC has occurred in access hole covers, probably always initiated in weld (below)	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	known issue in oxidizing environment; high residual stresses	
4	Low	High	High	Good field experience and supporting lab data.	
5	Medium	High	High	SCC has occurred in access hole covers, probably always initiated in weld	
6	Medium	High	High	There is an field experience.	
7	High	High	High	SS/Alloy 600 in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Known plant concern(PB-2,-3, QC-1,-2)	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.6**

Access Hole Cover (Ledge in Group 4)
Alloy 600 (some covers are SS)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC less than in NWC but also depends on level cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	High	known issue in oxidizing environment; high residual stresses	HWC effective?
4	Low	High	High	Good field experience and supporting lab data.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **6.7**

Alloy 182Welds for Access Hole Cover
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9,20
Notes: Neutron fluence ~< 0.2 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.7**

Alloy 182Welds for Access Hole Cover
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9,20

Notes: Neutron fluence ~< 0.2 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **6.7**

Alloy 182Welds for Access Hole Cover
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9,20

Notes: Neutron fluence ~< 0.2 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	high hydrogen?	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.7

Alloy 182Welds for Access Hole Cover
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9,20

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium	SCC has occurred in access hole covers	
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	known issue in oxidizing environments	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds.
5	Medium	High	High	SCC has occurred in access hole covers	
6	Medium	High	Medium	Susceptible under these condition and many field experiences	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Known plant concern	

Subgroup **6.7**

Alloy 182Welds for Access Hole Cover
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9,20
Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	known issue in oxidizing environments	sensitization
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **6.8**

Slip Fit on Jet Pump Mixer to Diffuser
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix JETPUMP
21

Notes: Wear from vibration causes leakage

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Medium	High	High	Fatigue loading assumed to be within code allowable but likely to interact with wear.	Fatigue loading and wear
3	Medium	High	High	high stress cycles a risk; vibration	
4	Medium	High	High	Could also be an environmental effect.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Medium	High	High	Ripple stress effects is not characterized in conjunction with SCC	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.8

Slip Fit on Jet Pump Mixer to Diffuser
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix JETPUMP
21

Notes: Wear from vibration causes leakage

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	Fatigue loading assumed to be within code allowable but likely to interact with wear as well as corrosion at low frequency.	Fatigue loading and wear
3	Medium	High	High	high stress cycles a risk; vibration	
4	Medium	High	High	Could also be an environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with cyclic loading
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.8

Slip Fit on Jet Pump Mixer to Diffuser
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi

Applies to BNL Part #s with prefix JETPUMP
21

Notes: Wear from vibration causes leakage

Fretting/Wear

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Medium	Difficult to predict. Tribo-corrosion depends on water chemistry	Flow induced vibration, water chemistry
3	Medium	High	High	issue if vibration causes relative motion	
4	Medium	High	High	Known problem.	
5	Low	High	High	Wear from vibration has caused leakage	
6	Low	High	Medium	Need more characterization.	
7	Medium	Medium	Medium	Evidence of wear in field; may be more wear in hydrogenated environment	
8	Medium	Medium	Medium	Certainly a potential factor that has been observed,	design issue

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.9

Riser brace or bracket weld to riser
308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.9

Riser brace or bracket weld to riser
308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Subgroup **6.9**

Riser brace or bracket weld to riser
308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, and thermal aging plus lack of data in environment. effect on FR	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.9

Riser brace or bracket weld to riser
308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed tube better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses, 308 more resistant	
8	Low	High	Medium	plant concern exacerbated by vibration loading. Susceptibility lessened by 308L duplex structure	

Subgroup **6.9**

Riser brace or bracket weld to riser
308L weld metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem should give effective mitigation	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.10**

Riser brace or bracket weld to riser - HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Subgroup **6.10**

Riser brace or bracket weld to riser - HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.10

Riser brace or bracket weld to riser - HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials/HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.10**

Riser brace or bracket weld to riser - HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium		
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ concerns	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	plant concern exacerbated by vibration loading	

Subgroup **6.10**

Riser brace or bracket weld to riser - HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
22

Notes: Neutron fluence ~< 0.5 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.11**

Jet Pump Adapter to Ledge
SS Adapter HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
17

Notes: Neutron fluence ~< 0.2 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Subgroup **6.11**

Jet Pump Adapter to Ledge
SS Adapter HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
17

Notes: Neutron fluence ~< 0.2 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.11**

Jet Pump Adapter to Ledge
SS Adapter HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
17

Notes: Neutron fluence ~< 0.2 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.11**

Jet Pump Adapter to Ledge
SS Adapter HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
17

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ concerns	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	plant concern exacerbated by vibration loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.11**

Jet Pump Adapter to Ledge
SS Adapter HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
17

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.12**

Alloy 182 Welds for Jet Pump Adapter to Ledge
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
18

Notes: Neutron fluence ~< 0.2 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Not aware of significant cyclic loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.12**

Alloy 182 Welds for Jet Pump Adapter to Ledge
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
18

Notes: Neutron fluence ~< 0.2 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	high cyclic stresses possible here	
4	Medium	High	High	Possible environmental effects and sensitive component loading. Know of no lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.12

Alloy 182 Welds for Jet Pump Adapter to Ledge
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
18

Notes: Neutron fluence ~< 0.2 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	high hydrogen?	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR data	
6	Medium	Medium	Medium	No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects in hardened HAZ.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.12**

Alloy 182 Welds for Jet Pump Adapter to Ledge
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
18

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High		
2	High	High	High	Significant risk of SCC in oxidizing conditions in Alloy 182	Stress, stress concentrations, water quality
3	Medium	High	High	known issue in oxidizing environments	
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds.
5	Medium	High	High	Alloy 182 is moderately susceptible	
6	Medium	High	Medium	Susceptible under these condition and many field experiences	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	plant concern exacerbated by vibration loading	

Subgroup **6.12**

Alloy 182 Welds for Jet Pump Adapter to Ledge
Alloy 182 Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
18

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Less vulnerable in HWC but PWR experience suggests that SCC only slowed down in HWC relative to NWC	Stress, stress concentrations, water quality
3	Medium	High	High	known issue in oxidizing environments	sensitization
4	Medium	High	Medium	Generic issue - field failures and supporting lab data.	Repair welds.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.13**

Jet Pump Adapter to JP Diffuser
SS HAZ on Adapter and Diffuser
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.13**

Jet Pump Adapter to JP Diffuser
SS HAZ on Adapter and Diffuser
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs high cyclic stress	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.13**

Jet Pump Adapter to JP Diffuser
SS HAZ on Adapter and Diffuser
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Medium	Medium	Medium	ferrite content an issue	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to steam/water	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.13**

Jet Pump Adapter to JP Diffuser
SS HAZ on Adapter and Diffuser
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ concerns	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	plant concern exacerbated by vibration loading	

Subgroup **6.13**

Jet Pump Adapter to JP Diffuser
SS HAZ on Adapter and Diffuser
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
19

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	oxidizing environment and fluence a risk; high stress also	sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process, irradiation, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **6.14**

Jet Pump Adapter to JP Diffuser Weld Metal
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9

Notes: Neutron fluence ~< 0.2 dpa

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	possible fatigue loading	

Subgroup **6.14**

Jet Pump Adapter to JP Diffuser Weld Metal
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9

Notes: Neutron fluence ~< 0.2 dpa

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental fatigue component	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.14**

Jet Pump Adapter to JP Diffuser Weld Metal
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9

Notes: Neutron fluence ~< 0.2 dpa

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Irradiation may have a long term effect.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, and thermal aging plus lack of data in environment. effect on FR	

Group
6

Reactor Coolant System

Jet Pump Assembly

Subgroup
6.14

Jet Pump Adapter to JP Diffuser Weld Metal
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed tube better but recent BWR core shroud crack showed that crack growed along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	Medium	plant concern exacerbated by vibration loading, lessened by duplex 308L structure	

Group **6** **Reactor Coolant System** **Jet Pump Assembly**

Subgroup **6.14**

Jet Pump Adapter to JP Diffuser Weld Metal
308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
525°F, 1059 psi, low fluence

Applies to BNL Part #s with prefix JETPUMP
9

Notes: Neutron fluence ~< 0.2 dpa

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.1

Feedwater Pipe & Header to T-Box Weld Metal
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High		

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.1

Feedwater Pipe & Header to T-Box Weld Metal
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.1**

Feedwater Pipe & Header to T-Box Weld Metal
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	Medium	Medium	Concern about degree of constraint and thermal aging kinetics plus lack of data on environment effect on FR	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.1**

Feedwater Pipe & Header to T-Box Weld Metal
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Medium	High	High	possible if high stresses/cold work and sensitized	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Low	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	High	High	Resistance to cracking due to duplex structure. No known plant failures in this structure.	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.1

Feedwater Pipe & Header to T-Box Weld Metal
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.2

Feedwater Pipe & Header to T-Box Welds HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Thermal fatigue an obvious issue (C.f. feedwater thermal sleeve problems). Uncertainty in analysis of strain amplitudes	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.2

Feedwater Pipe & Header to T-Box Welds HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.2

Feedwater Pipe & Header to T-Box Welds HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.2

Feedwater Pipe & Header to T-Box Welds HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	HAZ is susceptible to SCC	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry/sensitization
4	Medium	High	High	Lower temperature favourable.	C content, welding process, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ is highly susceptible to SCC.	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	An obvious concern, exacerbated by thermal cycles	

Subgroup **7.2**

Feedwater Pipe & Header to T-Box Welds HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
6

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry/sensitization/HWC ineffective
4	Medium	High	High	Lower temperature favourable.	C content, welding process, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.3

Feedwater Sparger Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Thermal fatigue an obvious issue (C.f. feedwater thermal sleeve problems). Uncertainty in analysis of strain amplitudes	

Subgroup **7.3**

Feedwater Sparger Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.3

Feedwater Sparger Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Concern primarily for higher YS materials, like weld HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	assumes no severe cold work	
4	Low	High	High	High loading stresses may influence.	
5	Low	High	Medium	Some effect of environment on FR may be possible but data are sparse	Transient loads, presence of defects
6	Low	High	High	It can be issue when a large thermal stress is generated inthis component. Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Should not be an issue	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.3**

Feedwater Sparger Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Annealed base metal is not that susceptible to SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry
4	Low	High	High	Low temperature favourable.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Annealed base metal is not very susceptible to SCC	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Wrought material (c.f. HAZ) generally not susceptible unless cold worked	

Subgroup **7.3**

Feedwater Sparger Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry
4	Low	High	High	Low temperature favourable.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Subgroup **7.4**

Feedwater Sparger Nozzle Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High		

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.4

Feedwater Sparger Nozzle Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.4**

Feedwater Sparger Nozzle Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Concern about degree of constraint and thermal aging kinetics plus lack of data on environment effect on FR	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.4**

Feedwater Sparger Nozzle Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Medium	High	High	possible if high stresses/cold work and sensitized	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Low	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	High	High	Resistance to cracking due to duplex structure. No known plant failures in this structure.	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.4**

Feedwater Sparger Nozzle Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.5**

Feedwater Sparger Nozzle Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	Medium	Medium	Thermal fatigue an obvious issue (C.f. feedwater thermal sleeve problems). Uncertainty in analysis of strain amplitudes in this particular ECCS component	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.5

Feedwater Sparger Nozzle Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group **7** **Reactor Coolant System**

ECCS Connections

Subgroup **7.5**

Feedwater Sparger Nozzle Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.5**

Feedwater Sparger Nozzle Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ is susceptible to SCC	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry/sensitization
4	Medium	High	High	Lower temperature favourable.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ is highly susceptible to SCC.	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	An obvious concern, exacerbated by thermal cycles	

Group **7** **Reactor Coolant System** **ECCS Connection**

Subgroup **7.5**

Feedwater Sparger Nozzle Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
427°F, 1045 psi

Applies to BNL Part #s with prefix ECCSCONN
8-20
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry/sensitization/HWC ineffective
4	Medium	High	High	Lower temperature favourable.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.6

Core Spray Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Thermal fatigue an obvious issue . Uncertainty in analysis of strain amplitudes	

Subgroup **7.6**

Core Spray Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.6

Core Spray Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Concern primarily for higher YS materials, like weld HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	assumes no severe cold work	
4	0	High	High	Component not in continuous use, so loading stresses not an issue.	
5	Low	High	Medium	Some effect of environment on FR may be possible but data are sparse	Transient loads, presence of defects
6	0	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Should not be an issue	

Group **7** **Reactor Coolant System**

ECCS Connections

Subgroup **7.6**

Core Spray Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Annealed base metal is not that susceptible to SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Annealed base metal is not very susceptible to SCC	
6	Low	High	High	Well characterized	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Wrought material (c.f. HAZ) generally not susceptible unless cold worked	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.6**

Core Spray Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry/sensitization/HWC ineffective
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.7

Core Spray Component
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High		

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.7

Core Spray Component
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Subgroup **7.7**

Core Spray Component
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Concern about degree of constraint and thermal aging kinetics plus lack of data on environment effect on FR	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.7

Core Spray Component
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Medium	High	High	possible if high stresses/cold work and sensitized	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Low	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	High	High	Resistance to cracking due to duplex structure. No known plant failures in this structure.	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.7

Core Spray Component
Type 308/L SS Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.8

Core Spray Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Thermal fatigue an obvious issue . Uncertainty in analysis of strain amplitudes in this particular ECCS component	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.8**

Core Spray Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.8

Core Spray Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.8

Core Spray Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	HAZ is susceptible to SCC	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry/sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ is highly susceptible to SCC.	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	An obvious concern, exacerbated by thermal cycles, if they exist. First observed in 1978 at Oyster Creek, Quad Cities, etc.. Further accelerating effects assigned to cold work.	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.8**

Core Spray Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
21-42
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work; failures seen	impurity ingress plus oxidizing chemistry/sensitization/HWC ineffective
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.9

LPCI Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Thermal fatigue an obvious issue . Uncertainty in analysis of strain amplitudes in these particular components	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.9

LPCI Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.9

LPCI Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Concern primarily for higher YS materials, like weld HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	assumes no severe cold work	
4	0	High	High	Component not in continuous use, so loading stresses not an issue.	
5	Low	High	Medium	Some effect of environment on FR may be possible but data are sparse	Transient loads, presence of defects
6	0	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Should not be an issue	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.9**

LPCI Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Annealed base metal is not that susceptible to SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Annealed base metal is not very susceptible to SCC	
6	Low	High	High	Well characterized	
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	High	High	Wrought material (c.f. HAZ) generally not susceptible unless cold worked	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.9**

LPCI Components
Type 304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry/sensitization/HWC ineffective
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	

Subgroup **7.10**

LPCI Component Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High		

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.10**

LPCI Component Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Subgroup **7.10**

LPCI Component Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	Medium	Medium	Concern about degree of constraint and thermal aging kinetics plus lack of data on environment effect on FR	

Subgroup **7.10**

LPCI Component Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	Oxygenated solutions and residual stresses	
8	Low	High	High	Resistance to cracking due to duplex structure. No known plant failures in this structure.	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.10**

LPCI Component Weld Metal
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, oxidation potential
3	Low	High	High	possible if high stresses/cold work	impurity ingress plus oxidizing chemistry
4	Low	High	High	Good field experience	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	0	High	Medium	HWC/Noblechem effective mitigation	

Group
7

Reactor Coolant System

ECCS Connections

Subgroup
7.11

LPCI Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Thermal fatigue an obvious issue . Uncertainty in analysis of strain amplitudes in this particular ECCS component	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.11**

LPCI Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	flow-induced vibration or thermal cycling	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	Medium	HWC/Noblechem would mitigate if there was an environmental component dependant on loading frequency	

Subgroup **7.11**

LPCI Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Group
7

Reactor Coolant System

ECCS Connection

Subgroup
7.11

LPCI Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ is susceptible to SCC	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work;	impurity ingress plus oxidizing chemistry/sensitization
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZ is highly susceptible to SCC.	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	An obvious concern, exacerbated by thermal cycles, if they exist	

Group **7** **Reactor Coolant System** **ECCS Connections**

Subgroup **7.11**

LPCI Component Weld HAZ
Type 304 SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
533°F, 1059 psi

Applies to BNL Part #s with prefix ECCSCONN
43-50

Notes: Need to deal with ID & OD, normal & operating

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if high stresses/cold work;	impurity ingress plus oxidizing chemistry/sensitization/HWC ineffective
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	Medium	Medium	Low potential and residual stresses	
8	Low	High	Medium	HWC/Noblechem effective mitigation	

Group **8** **Reactor Coolant System** **Steam Separator & Dryer**

Subgroup **8.1**

Steam Separator and Dryer Assembly
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Significant fatigue loading in some areas	
2	Medium	Medium	Medium	Fatigue loading in head / steam environment known to be very design sensitive	Fatigue loading
3	Low	High	High	unlikely unless assembly subjected to high cyclic stresses; FIV a possibility for bolts	
4	High	High	Medium	Failures reported. Especially for power uprated plants	Loading situation not well defined and lack of data in steam environment.
5	Medium	High	Medium	Significant fatigue loading in some areas	
6	Medium	High	High	Fatigue loading is significant	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Low	Fatigue failure possible under forced conditions (e.g. power uprate) for certain dryer designs	hard to analyse due to complex resonance modes.

Subgroup **8.1**

Steam Separator and Dryer Assembly
304SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Annealed base metal is not that susceptible to SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Low	High	High	possible in oxygenated wet conditions if components sensitized; unlikley here	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content and cold work aggravating factors.
5	Low	High	High	Annealed base metal is not very susceptible to SCC	
6	Medium	High	High	Field experience and cold work enhances susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Shallow cracking observed in wrought components (e.g. dryer skirt) which was cold formed .	

Subgroup **8.2**

Steam Separator and Dryer Assembly Welds
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Significant fatigue loading in some areas	
2	Medium	Medium	Medium	Fatigue loading in head / steam environment known to be very design sensitive	Fatigue loading, presence of weld defects
3	Low	High	High	unlikely unless assembly subjected to high cyclic stresses; FIV a possibility for bolts	
4	High	High	Medium	Failures reported. Especially for power uprated plants	Loading situation not well defined and lack of data in steam environment.
5	Medium	High	Medium	Significant fatigue loading in some areas	
6	Medium	High	High	Fatigue loading source is significant.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High		

Subgroup **8.2**

Steam Separator and Dryer Assembly Welds
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of wet steam environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	weld ferrite content	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	Medium	Medium	High toughness and low stress under a normal condition. No systematic data on toughness and fracture resistance on weld after a long term exposure to hydrogenated steam/water and LTA. More effects with irradiation.	There are some evidences in Labs. Showing the reduction of Ji value in BWR environment but not so much as LTC in Ni-base alloy. Loading rate is critical. Effects of hydrogen in reduction in Ji is not clear. LTA may accelerate this reduction.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	Medium	Medium	Concern about degree of constraint and thermal aging kinetics plus lack of data on environment effect on FR	

Subgroup **8.2**

Steam Separator and Dryer Assembly Welds
Type 308/L Weld Metal
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Weld metal is not very susceptible to SCC	
2	Low	High	High	Low risk of SCC even in oxidizing wet steam conditions due to duplex microstructure	Water quality
3	Medium	High	High	possible in oxygenated wet conditions if components sensitized; unlikley here	
4	Low	High	High	Good field experience.	
5	Low	High	High	Weld metal is not very susceptible to SCC	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Resistance to cracking due to duplex structure. No known plant failures in this structure.	

Subgroup **8.3**

Steam Separator & Dryer Assembly Weld HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Significant fatigue loading in some areas	
2	Medium	Medium	Medium	Fatigue loading in head / steam environment known to be very design sensitive	Fatigue loading
3	Low	High	High	unlikely unless assembly subjected to high cyclic stresses; FIV a possibility for bolts	
4	High	High	Medium	Failures reported. Especially for power uprated plants	Loading situation not well defined and lack of data in steam environment.
5	Medium	High	Medium	Significant fatigue loading in some areas	
6	Medium	High	High	Fatigue loading source is significant.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	High	High	Medium	Fatigue failure possible under forced conditions (e.g. power uprate) for certain dryer designs	knowledge score based on a compromise between laboratory data (3) and lack of definition of plant operating conditions (1)

Subgroup **8.3**

Steam Separator & Dryer Assembly Weld HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of wet steam environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	weld ferrite content	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment. effect on FR	

Subgroup **8.3**

Steam Separator & Dryer Assembly Weld HAZ
304SS HAZ
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
1,2,5-8
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ is susceptible to SCC	
2	High	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality
3	Medium	High	High	possible in oxygenated wet conditions if components sensitized	
4	High	High	High	Generic problem. Poor inspection techniques can delay detection.	C content, welding process and cold work aggravating factors.
5	Medium	High	High	HAZ is highly susceptible to SCC. HWC not effective above the core	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Cracking observed in Steam dryers at HAZ, exacerbated by oxidising condition of steam condensate	

Subgroup **8.4**

Steam Separator and Dryer Assembly
ASTM A193, Gr. B8
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
3,4,9
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Medium	Medium	Medium	Fatigue loading in head / steam environment known to be very design sensitive	Fatigue loading
3	Low	High	High	unlikely unless assembly subjected to high cyclic stresses; FIV a possibility for bolts	
4	Medium	High	Medium	Failures reported. Environment can aggravate.	Loading situation not well defined and lack of data in steam environment.
5	Low	Medium	Medium	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is minor.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High		

Subgroup **8.4**

Steam Separator and Dryer Assembly
ASTM A193, Gr. B8
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
3,4,9
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of wet steam environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	if highly cold worked	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	Medium	Medium		

Subgroup **8.4**

Steam Separator and Dryer Assembly
ASTM A193, Gr. B8
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
3,4,9
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Low	High	High	possible in oxygenated wet conditions if components sensitized	
4	Low	High	High	Good field experience.	
5	Low	Medium	Medium	Susceptibility assumed low	
6	Low	Medium	Medium	Need more data on SCC of LAS under thin film of water.	
7	High	High	High	LAS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	Medium		

Group **8** **Reactor Coolant System**

Steam Separator & Dryer

Subgroup **8.5**

Steam Separator Guide Pin
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
10
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Fatigue loading unclear	
2	Medium	Medium	Medium	Fatigue loading in head / steam environment known to be very design sensitive	Fatigue loading
3	Low	High	High	unlikely unless assembly subjected to high cyclic stresses;	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Medium	Medium	Medium	Fatigue loading assumed moderate	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Fatigue loading unclear	

Subgroup **8.5**

Steam Separator Guide Pin
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
10
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of wet steam environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	if highly cold worked	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	FR concern primarily for high YS materials. Therefore not a concern in this component	

Subgroup **8.5**

Steam Separator Guide Pin
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
10
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Annealed base metal is not that susceptible to SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Low	High	High	possible in oxygenated wet conditions if components sensitized	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content and cold work aggravating factors.
5	Low	High	High	Annealed base metal is not very susceptible to SCC	
6	Medium	High	High	Field experience and cold work enhances susceptibility	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Not likely in annealed base material	

Group **8** **Reactor Coolant System** **Steam Separator & Dryer**

Subgroup **8.6**

RCIC Head Spray Nozzle
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
11-14
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Medium	Medium	Medium	Fatigue loading in head / steam environment known to be very design sensitive	Fatigue loading
3	Low	High	High	unlikely unless assembly subjected to high cyclic stresses;	
4	Medium	High	High	Some failures reported.	
5	Low	Medium	Medium	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading source is thermal stress.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Fatigue loading unclear	

Subgroup **8.6**

RCIC Head Spray Nozzle
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
11-14
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR concern primarily for high YS materials	
2	Low	High	Medium	Some effect of wet steam environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	if highly cold worked	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Not a issue under normal condition	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	FR concern primarily for high YS materials. Therefore not a concern in this component	

Subgroup **8.6**

RCIC Head Spray Nozzle
304 SS
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
550°F, 1045 psi, wet steam

Applies to BNL Part #s with prefix STMSEP
11-14
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Annealed base metal is not that susceptible to SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions in steam space depends on level of cold work and water quality	Stress, metallurgical condition, water quality
3	Low	High	High	possible in oxygenated wet conditions if components sensitized	
4	Medium	High	High	Generic problem. Poor inspection techniques can delay detection.	C content and cold work aggravating factors.
5	Low	High	High	Annealed base metal is not very susceptible to SCC	
6	Low	Medium	Medium	Need more data on SCC of SS under thin film of water.	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Not likely in annealed base material	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.1** All Stainless Steel Components
External Surfaces When at <150°C
Normally Dry When at Low Temp

Applies to BNL Part #s with prefix RECIRC
All SS components

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No indication of Cl or humidity - significant problem if these are present	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	only an issue if alternately wet/dry with surface impurities accumulating	
4	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.
5	Low	High	High	External surfaces are dry during power operation	Moisture and chlorides are prerequisites
6	Low	High	High	Contamination of surface is critical. From insulators and/or air especially during a construction.	Contamination
7	Low	Medium	Medium	Pitting if contaminated	
8	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

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.1

All Stainless Steel Components
External Surfaces When at <150°C
Normally Dry When at Low Temp

Applies to BNL Part #s with prefix RECIRC
All SS components

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	No indication of Cl or humidity - significant problem if these are present	all pipes and elbows have two seam welds. ODSCC is possible when external surface is wet with Cl etc.
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	only an issue if alternately wet/dry with surface impurities accumulating	all pipes and elbows have two seam welds. ODSCC is possible when external surface is wet with Cl etc.
4	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.
5	Low	High	High	External surfaces are dry during power operation	Moisture and chlorides are prerequisites
6	Low	High	High	Contamination of surface is critical. From insulators and/or air especially during a construction.	all pipes and elbows have two seam welds. ODSCC is possible when external surface is wet with Cl etc.
7	Low	High	High	Contamination on outside if open to outside even for short times	all pipes and elbows have two seam welds. ODSCC is possible when external surface is wet with Cl etc.
8	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.

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.2**

LAS, SA-508 Cl.2 (Forged Ring)
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Crevice can promote SCC, but crevice corrosion itself should not be an issue	
2	Low	High	High	High oxygen facilitates crevice corrosion but should be limited by good water quality	Water quality
3	Low	High	High	potential for SCC initiation	
4	0	High	High	No crevice	
5	0	High	High	Crevice can promote SCC, but crevice corrosion itself should not be an issue	
6	Low	High	High	Contamination of surface is critical. From insulators and/or air especially during a construction.	
7	Medium	Medium	Medium	Oxygenated	
8	Low	High	High	Should not be an issue. Hard to judge given apparent lack of geometry requirements	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.2**

LAS, SA-508 Cl.2 (Forged Ring)
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Medium	High	High	Fatigue loading within code allowable but high CUF a concern - oxygen content high, which facilitates corrosion fatigue at low frequency in low alloy steels	Fatigue loading, plant life extension
3	Medium	High	High	an issue	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible.
5	Low	Medium	High	CUF is fairly high when environment effect is included	
6	Medium	High	Medium	Need more detailed analysis	Environmental factor must be quantify for CUF evaluation.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	A definite issue given oxygenated environment and high CUF. Lower knowledge score mirroring imprecise definition of loading conditions	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.2**

LAS, SA-508 Cl.2 (Forged Ring)
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading within code allowable but high CUF a concern	Fatigue loading, plant life extension
3	Medium	High	High	an issue	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in a long-term performance is not clear yet. Can be harmful.	Long term effects of f Hydrogen in fatigue is not clear.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.2**

LAS, SA-508 Cl.2 (Forged Ring)
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High toughness and no irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	cold work increases susceptibility	
4	Low	High	Medium	Some effect of environment on FR may exist.	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Unlikely a reduction in Fracture Resistance	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	Medium	Would be zero susceptibility score since no clear embrittlement mechanism is applicable. "upgraded to a "1" score to denote lack of FR data in the environment.	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.2**

LAS, SA-508 Cl.2 (Forged Ring)
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	High oxygen a concern offset by good water quality	Sulfur content of steel and orientation of inclusions relative to surface
3	Low	High	High	possible if highly stressed/cold worked	
4	Low	High	High	Good experience. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Low-alloy steel is not very susceptible	
6	Low	High	High	Minor effects of environment	
7	High	High	High	LAS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	Medium	Not likely under pure constant load/displacement. Low knowledge score denoting uncertain effect of dynamic loading(see scoring on fatigue)	

Subgroup **9.2**

LAS, SA-508 Cl.2 (Forged Ring)
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Not a significant concern in HWC	Sulfur content of steel and orientation of inclusions relative to surface, duration of periods without HWC
3	Low	High	High	possible if highly stressed/cold worked	
4	Low	High	High	Good experience. Good lab data.	Requires specific loading conditions.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	In terms of long term performance, hydrogen may not be beneficial.	Long term effects of f Hydrogen in SCC is not clear.
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.3**

LAS, SA-508 Cl.2 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High	Crevice can promote SCC, but crevice corrosion itself should not be an issue	
2	Low	High	High	High oxygen facilitates crevice corrosion but should be limited by good water quality	Water quality
3	Low	High	High	potential for SCC initiation	
4	0	High	High	No crevice.	
5	0	High	High	Crevice can promote SCC, but crevice corrosion itself should not be an issue	
6	Low	High	High	Contamination of surface is critical. From insulators and/or air especially during a construction.	
7	Medium	Medium	Medium	Oxygenated	
8	Low	High	High	Should not be an issue. Hard to judge given apparent lack of geometry requirements	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.3**

LAS, SA-508 Cl.2 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Medium	High	High	Fatigue loading within code allowable but high CUF a concern - oxygen content high, which facilitates corrosion fatigue at low frequency in low alloy steels	Fatigue loading, plant life extension
3	Medium	High	High	an issue	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible.
5	Low	Medium	High	CUF is fairly high when environment effect is included	
6	Medium	High	Medium	Need more detailed analysis	Environmental factor must be quantify for CUF evaluation.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	A definite issue given oxygenated environment and high CUF. Lower knowledge score mirroring imprecise definition of loading conditions	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.3**

LAS, SA-508 Cl.2 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading within code allowable but high CUF a concern	Fatigue loading, plant life extension
3	Medium	High	High	an issue	
4	Low	High	High	This degradation mechanism was the design basis for the component.	Environmental effect possible.
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in a long-term performance is not clear yet. Can be harmful.	Long term effects of f Hydrogen in fatigue is not clear.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.3**

LAS, SA-508 Cl.2 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	FR in-situ in high YS materials a concern; but LAS is presumably tempered after welding	
2	Low	High	High	High toughness and no irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	cold work increases susceptibility	cold bent elbows, surface grining, etc. a concern
4	Low	High	Medium	Some effect of environment on FR may exist.	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	Unlikely a reduction in Fracture Resistance	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	Medium	Medium	Would be zero susceptibility score since no clear embrittlement mechanism is applicable. "upgraded to a "1" score to denote lack of FR data in the environment and uncertainty in effect of plastic constraint of weld.	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.3**

LAS, SA-508 Cl.2 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Concern for HAZ, but LAS is presumably tempered after welding	
2	Medium	High	High	High oxygen a concern offset by good water quality	Sulfur content of steel and orientation of inclusions relative to surface, residual stress
3	Low	High	High	possible if highly stressed/cold worked	
4	Low	High	High	Good experience. Good lab data.	Requires specific loading conditions.
5	Medium	High	High	HAZ is high-stress area	
6	Low	High	High	Minor effects of environment	HAZ can be a potential concern.
7	High	High	High	LAS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	Not likely under pure constant load/displacement but susceptibility score increased over base to denote possible effect of increase in YS at HAZ.. Low knowledge score denoting uncertain effect of dynamic loading(see scoring on fatigue)	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.3**

LAS, SA-508 Cl.2 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Not a significant concern in HWC	Sulfur content of steel and orientation of inclusions relative to surface, residual stress, duration of periods without HWC
3	Low	High	High	possible if highly stressed/cold worked	
4	Low	High	High	Good experience. Good lab data.	Requires specific loading conditions.
5	Low	High	High	HWC should help here	
6	--	--	--	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.4

Dissimilar metal welds LAS to SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Medium	High	High	Fatigue loading within code allowable but high CUF a concern - oxygen content high, which facilitates corrosion fatigue in low alloy steels at low frequency (should not be a factor for stainless steels)	Fatigue loading, plant life extension
3	Medium	High	High	an issue	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	CUF is fairly high when environment effect is included	
6	Medium	High	Medium	Need more detailed analysis	Environmental factor must be quantify for CUF evaluation.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	High usage factor would denote a potential concern	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.4

Dissimilar metal welds LAS to SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Fatigue loading within code allowable but high CUF a concern - HWC facilitates corrosion fatigue in SS at low frequency	Fatigue loading, plant life extension
3	Medium	High	High	an issue	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen in a long-term performance is not clear yet. Can be harmful for aged two phase 308..	Role of Hydrogen in fatigue.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.4**

Dissimilar metal welds LAS to SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High toughness and no significant irradiation damage	Presence of defects and transient loads under accident conditions
3	Low	Medium	Medium	residual stresses could be high	weld stresses equivalent to cold work
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	FR reduction by thermal aging in 308 is likely	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.4

Dissimilar metal welds LAS to SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in duplex SS is low even in oxidizing conditions	Stress, metallurgical condition especially excessive dilution with low alloy steel, water quality
3	Medium	High	High	an issue if weld sensitized	
4	Low	High	High	Good field experience.	
5	Low	High	High	Type 308 is not very susceptible	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	Oxygenated, residual stresses	
8	Low	High	High	Not likely to be a problem with duplex stainless steel but susceptibility kept at "1" due to uncertain effects of dynamic loading	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.4

Dissimilar metal welds LAS to SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)
CUF 0.48 w env effect

Applies to BNL Part #s with prefix RECIRC
1
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, metallurgical condition especially excessive dilution with low alloy steel, oxidation potential when HWC not functioning
3	Low	High	High	an issue if weld sensitized	hydrogen chemistry effective
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Low	High	High	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.5

Safe-end, SS 316NG
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	unlikely here	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	Medium	Need more detailed analysis	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Unlikely in wrought alloy in good purity coolant, with minimal cyclic loading (low CUF values assumed?)	

Subgroup **9.5**

Safe-end, SS 316NG
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	unlikely here	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Role of hydrogen should be studied from a mechanistic point of view.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.5**

Safe-end, SS 316NG
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	
4	Low	Medium	Medium	Only a potential problem for high yield strength material.	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	J-R curves may be affected by environments.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.5**

Safe-end, SS 316NG
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely with this alloy	
4	Low	High	High	Good field experience. Cold work may aggravate.	
5	Low	High	High	Wrought nuclear grade SS isn't very susceptible	
6	Low	High	High	Normally high resistance to SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Unlikely in wrought alloy in good purity coolant	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.5

Safe-end, SS 316NG
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	0	High	High	unlikely with this alloy	
4	Low	High	High	Good field experience. Cold work may aggravate.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.6

316 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if subjected to high cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	Medium	Need more detailed analysis	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	Medium	Assume that the fatigue loading is low (based on low? CUF)	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.6

316 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if subjected to high cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.6

316 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	unlikely here	weld ferrite content should be OK
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	J-R curves may be affected by environments.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Subgroup **9.6**

316 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for HAZ	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	if sensitized, a concern	
4	Medium	High	Medium	Cold work and welding process aggravate.	
5	High	High	High	HAZ is highly susceptible -- lots of recirc cracks in lots of plants	
6	Medium	High	High	Many field experience	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Possible especially if the specified water purity is not maintained	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.6**

316 HAZ
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
2

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, periods without HWC, oxidation potential
3	Medium	High	High	if sensitized, a concern; assumes HWC effective	hydrogen chemistry effective
4	Medium	High	High	Cold work and welding process aggravate.	
5	Low	High	High	HWC known to help here	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.7

Welds SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
3,5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	possible if subjected to high cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading assumed small	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	High	High usage factor would denote a potential concern	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.7**

Welds SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
3,5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	possible if subjected to high cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.7

Welds SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
3,5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	Medium	Medium	depends on ferrite content of weld	
4	Low	Medium	Medium	Not as susceptible as cast material, but depending on ferrite content could be a potential problem.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	J-R curves may be affected by environments.	delta ferrite content
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	Medium	Not likely to be a problem with duplex stainless steel but knowledge score lower to indicate uncertainty in thermal aging/ ferrite content relationship and effect of environment on FR data	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.7

Welds SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
3,5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Limited concern for SCC in weld metal	delta ferrite content
2	Low	High	High	Low risk of SCC even in oxidizing conditions due to duplex microstructure	Water quality
3	Medium	High	High	if sensitized, a concern	delta ferrite content
4	Low	High	High	Good field experience.	
5	Low	High	High	Limited concern for SCC in weld metal	delta ferrite content
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	Medium	Medium	Medium	More resistant to SCC, oxygenated	delta ferrite content
8	Low	High	High	Not likely to be a problem with duplex stainless steel but susceptibility kept at "1" due to uncertain effects of dynamic loading	delta ferrite content

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.7**

Welds SS 308
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
3,5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC due to duplex microstructure	Water quality, periods without HWC, oxidation potential
3	Low	High	High	if sensitized, a concern; assumes HWC effective	hydrogen chemistry effective
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.8

Straight pipe SS Type 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
4

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	all pipes and elbows have two seam welds
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	unlikely here	welds if vibrations excessive
4	Low	High	High	Good field experience.	all pipes and elbows have two seam welds
5	Low	Medium	High	Not aware of significant fatigue loading	all pipes and elbows have two seam welds
6	Low	High	High	Fatigue loading assumed small	all pipes and elbows have two seam welds
7	Low	Medium	Medium	Depends on configuration and stressing	all pipes and elbows have two seam welds
8	Low	High	High	Unlikely since no obvious cyclic loading	all pipes and elbows have two seam welds

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.8

Straight pipe SS Type 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
4

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	unlikely here	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.8

Straight pipe SS Type 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
4

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Limited concern for SCC in base metal	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here unless cold worked or highly stressed	all pipes and elbows have two seam welds
4	Low	High	High	Good field experience.	all pipes and elbows have two seam welds
5	Low	High	High	Limited concern for SCC in base metal	
6	Low	High	High	Normally high resistance to SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Unlikely in base material unless severely cold worked	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.8**

Straight pipe SS Type 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
4

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here unless cold worked or highly stressed	all pipes and elbows have two seam welds
4	Low	High	High	Good field experience.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.9**

HAZ 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87,

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	welds most at risk if high cyclic stresses present	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading assumed small	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	No obvious cyclic loading component	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.9**

HAZ 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87,

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	welds most at risk if high cyclic stresses present	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.9

HAZ 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87,

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium		
3	Low	Medium	Medium	unlikely	delta ferrite should be OK
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	J-R curves may be affected by environments.	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.9**

HAZ 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87,

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for HAZ	
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if weld sensitized	
4	High	High	High	Generic problem.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	High	High	High	HAZ is highly susceptible -- lots of cracks in lots of plants	
6	Medium	High	High	Many field experience	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	High	Certainly a very well recognized problem if the water chemistry purity spec is violated	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.9**

HAZ 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
5,7,9,12,14,16,18,22,28,30,31,33,35,38,41,43,45,46,48,50,52,54,56,58,60,62,64,66,67,69,71,73,75,77,79,81,83,85,87,

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, periods without HWC, oxidation potential
3	Low	High	High	possible if weld sensitized; assumes HWC effective	hydrogen chemistry effective
4	High	High	High	Generic problem.	C content, cold work, welding process and historically poor chemistry aggravating factors.
5	Low	High	High	HWC known to help here	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.10**

Straight pipe SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
8,10,15,34,40,47,51,55,61,63,68,72,78,80,84,86

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	all pipes and elbows have two seam welds
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	unlikely here	all pipes and elbows have two seam welds
4	Low	High	High	Good experience. Possible environmental effect.	all pipes and elbows have two seam welds
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading assumed small	all pipes and elbows have two seam welds
7	Low	Medium	Medium	Depends on configuration and stressing	all pipes and elbows have two seam welds
8	Low	High	High	Unlikely since no obvious cyclic loading	all pipes and elbows have two seam welds

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.10**

Straight pipe SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
8,10,15,34,40,47,51,55,61,63,68,72,78,80,84,86

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	unlikely here	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.10**

Straight pipe SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
8,10,15,34,40,47,51,55,61,63,68,72,78,80,84,86

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here unless cold worked or highly stressed	all pipes and elbows have two seam welds
4	Low	High	High	C content, cold work and historically poor chemistry aggravating factors.	
5	Low	High	High	Wrought Type 304 is not very susceptible	all pipes and elbows have two seam welds
6	Low	High	High	Normally high resistance to SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Unlikely in base material unless severely cold worked	all pipes and elbows have two seam welds, which are usually solution heat treated

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.10**

Straight pipe SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
8,10,15,34,40,47,51,55,61,63,68,72,78,80,84,86

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely here unless cold worked or highly stressed	
4	Low	High	High	C content, cold work and historically poor chemistry aggravating factors.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Subgroup **9.11**

Elbows SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
6,19,27,44,53,59,82

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	all pipes and elbows have two seam welds
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	unlikely to be an issue here unless piping subject to high cyclic stresses	all pipes and elbows have two seam welds
4	Low	High	High	Good experience. Possible environmental effect.	all pipes and elbows have two seam welds
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading assumed small	all pipes and elbows have two seam welds
7	Low	Medium	Medium	Depends on configuration and stressing	all pipes and elbows have two seam welds
8	Low	High	High	Unlikely since no obvious cyclic loading	all pipes and elbows have two seam welds

Subgroup **9.11**

Elbows SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
6,19,27,44,53,59,82

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	unlikely to be an issue here unless piping subject to high cyclic stresses	welds at risk if vibrations excessive
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.11**

Elbows SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
6,19,27,44,53,59,82

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work (assumed < 2.5% here) and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	if cold worked, an issue	all pipes and elbows have two seam welds
4	Medium	High	High	Generic problem with cold worked surface.	C content and historically poor chemistry aggravating factors.
5	Low	High	High	Forged Type 304 is nor very susceptible	all pipes and elbows have two seam welds
6	Low	High	High	Normally high resistance to SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Unlikely in base material unless severely cold worked	all pipes and elbows have two seam welds, which are usually solution heat treated

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.11**

Elbows SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
6,19,27,44,53,59,82

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	if cold worked, an issue	all pipes and elbows have two seam welds
4	Medium	High	High	Generic problem with cold worked surface.	C content and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.12

Tee SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
13

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	unlikely to be an issue here unless piping subject to high cyclic stresses	
4	Low	High	High	Good field experience but thermal fatigue cannot be excluded. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Fatigue loading assumed small	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	Medium	Unlikely unless there is a component due to thermal loading (associated with eddies)	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.12

Tee SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
13

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	unlikely to be an issue here unless piping subject to high cyclic stresses	
4	Low	High	High	Good field experience but thermal fatigue cannot be excluded. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Subgroup **9.12**

Tee SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
13

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Limited concern for SCC in base metal	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	if cold worked, an issue	
4	Medium	High	High	Generic problem with cold worked surface.	C content and historically poor chemistry aggravating factors.
5	Low	High	High	Limited concern for SCC in base metal	
6	Low	High	High	Normally high resistance to SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Unlikely in base material unless severely cold worked	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.12

Tee SS Type 304
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
13

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	if cold worked, an issue	
4	Medium	High	High	Generic problem with cold worked surface.	C content and historically poor chemistry aggravating factors.
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.13**

Socket Welds SS 308 on 304 and 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
17,20,21,24,25,26,32,39,42,65,76

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Relatively low risk of crevice corrosion in good quality reactor water	Water quality
3	Low	High	High	unlikely but a concern if water chemistry degrades; oxygenated water	
4	Low	High	High	Geometrical crevices might exist.	
5	0	High	High	Crevice can promote SCC, but crevice corrosion itself should not be an issue	
6	Medium	High	High	Microstructural changes in 308 after LAT may increase crevice corrosion susceptibility.	pH and microstructure
7	Low	Medium	Medium	In oxygenated environment crevice corrosion can be expected	
8	Low	High	High	Possible under "normal water chemistry, but not hydrogen water chemistry	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.13**

Socket Welds SS 308 on 304 and 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
17,20,21,24,25,26,32,39,42,65,76

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assume all socket welds have fatigue problems	
2	Medium	High	High	Fatigue loading of socket welds design sensitive.	Flow induced vibration
3	Medium	High	High	most susceptible components if cyclic stresses present in the piping	
4	High	High	Medium	Loading undefined. Numerous failures reported.	
5	High	High	Medium	Socket welds have failed at several plants due to vibration loads	
6	High	High	High	Many field experiences. One of the greatest concern.	
7	Medium	Medium	Medium	Socket weld prone to fatigue	
8	High	High	Medium	A known problem in operating plant	

Subgroup **9.13**

Socket Welds SS 308 on 304 and 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
17,20,21,24,25,26,32,39,42,65,76

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Fatigue loading of socket welds design sensitive. Possible effect of HWC on corrosion fatigue for low frequency loading	Flow induced vibration
3	Medium	High	High	most susceptible components if cyclic stresses present in the piping	
4	High	High	Medium	Loading undefined. Numerous failures reported.	
5	High	High	Medium	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Medium	Medium	Medium	Socket weld prone to fatigue	
8	Medium	High	High	Environmental effect dependent on loading conditions, but may be increased by HWC/Noblechem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.13**

Socket Welds SS 308 on 304 and 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
17,20,21,24,25,26,32,39,42,65,76

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	HAZ concerns	
2	Medium	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if weld sensitized	
4	Medium	High	High	Could initiate from pitting.	
5	Medium	High	High	HAZ concerns	
6	Medium	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal.	LTA should be considered.
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Medium	High	Medium	A potential problem in HAZ if water purity not maintained. Lower knowledge score due to undefined dynamic loading	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.13**

Socket Welds SS 308 on 304 and 316
550°F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
17,20,21,24,25,26,32,39,42,65,76

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	possible if weld sensitized; assumes HWC effective	hydrogen chemistry effective
4	Medium	High	High	Could initiate from pitting.	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.14**

Flange SA 182, GR F316
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
36,37

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Relatively low risk of crevice corrosion in good quality reactor water	Water quality
3	Low	High	High	unlikely but a concern if water chemistry degrades; oxygenated water	
4	Low	High	High	Geometrical crevice.	
5	0	High	High	Crevice can promote SCC, but crevice corrosion itself should not be an issue	
6	Low	High	High	Leak can provide a condition for CREV	Laek
7	Low	Medium	Medium	In oxygenated environment crevice corrosion can be expected	
8	Low	High	High	Possible under "normal water chemistry, but not hydrogen water chemistry	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.14

Flange SA 182, GR F316
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
36,37

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Any impact from crevice corrosion?	
7	Medium	Medium	Medium	Carbon steel more prone to Fat	
8	Low	High	High	Good plant experience	

Subgroup **9.14**

Flange SA 182, GR F316
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
36,37

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good field experience	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Medium	Medium	Medium	Carbon steel more prone to Fat	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Subgroup **9.14**

Flange SA 182, GR F316
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
36,37

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	possible if flange cold worked or highly stressed	
4	Low	High	High	Good field experience	
5	Low	High	High		
6	Low	High	High	Normally high resistance to SCC	
7	High	Medium	Medium	oxygenated, residual stresses	
8	Low	High	High	Good plant experience. Manageable via control of water purity	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.14**

Flange SA 182, GR F316
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
36,37

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	possible if flange cold worked or highly stressed	
4	Low	High	High	Good field experience	
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial.	
7	Low	Medium	Medium	Low potential, residual stresses	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.15**

Cast SS CF-8 and CF-8M
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
23,29,49,57,88,90

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Any impact from crevice corrosion?	
7	Medium	Medium	Medium	Casting defects	
8	Low	High	High	Good plant experience, uncertain source of cyclic loading	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.15

Cast SS CF-8 and CF-8M
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
23,29,49,57,88,90

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good field experience. Known environmental effect from lab data.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation. Synergy effects of LTA hardening and hydrogen is not clear.	Role of hydrogen should be studied from a mechanistic point of view.
7	Medium	Medium	Medium	Casting defects	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.15

Cast SS CF-8 and CF-8M
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
23,29,49,57,88,90

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Some concern for aged, cast SS	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects, thermal aging
3	Low	Medium	Medium	ferrite content the issue	
4	Low	Medium	Medium	Depending on ferrite content could be a potential problem for cast material.	Not studied at these temperatures, and would expect the PWRs to experience first, if at all.
5	Medium	High	High	Some concern for thermally aged, cast SS but models are available and predictions are reasonably accurate	
6	Low	High	High	J-R curves may be affected by environments.	LTA hardening may affect FR
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	Medium	No plant incidence , and unlikely at the lower BWR (compared with PWR) temperatures, but uncertainty regarding kinetics of thermal aging and effect of environment on FR data	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.15**

Cast SS CF-8 and CF-8M
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
23,29,49,57,88,90

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Some concern for aged, cast SS	
2	Medium	Medium	Low	SCC properties in oxidizing conditions after thermal aging not known	Probably extent of thermal aging
3	Low	High	High	possible if highly stressed	
4	Low	High	High	Good field experience, but some evidence could occur.	
5	Low	High	High	Some concern for thermally aged, cast SS	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal. Sensitization is also concern.	LTA should be considered.
7	Medium	Medium	Medium	Oxygenated	
8	Low	High	Medium	Good plant experience but very little SCC data to analyse the extent of the margin	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.15**

Cast SS CF-8 and CF-8M
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
23,29,49,57,88,90

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	Medium	Low	SCC properties in HWC after thermal aging	Probably extent of thermal aging
3	Low	High	High	possible if highly stressed	
4	Low	High	High	Good field experience, but some evidence could occur.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial. Synergy effects of LTA hardening and hydrogen is not clear.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.16

Reducing Branch SS 304
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
70

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Normally no fatigue loading can be assumed.	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Uncertain source of cyclic loading. Good plant experience	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.16**

Reducing Branch SS 304
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
70

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.16

Reducing Branch SS 304
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
70

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Limited concern for SCC	
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	possible if highly stressed	
4	Low	High	High	C content, cold work and historically poor chemistry aggravating factors.	
5	Low	High	High	Limited concern for SCC	
6	Low	High	High	Normally high resistance to SCC	
7	High	High	High	SS in oxygenated water at reactor temperature, residual stresses	
8	Low	High	High	Unlikely in wrought material under good water purity, unless highly cold worked	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.16

Reducing Branch SS 304
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
70

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	possible if highly stressed	
4	Low	High	High	C content, cold work and historically poor chemistry aggravating factors.	
5	Low	High	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial. Synergy effects of LTA hardening and hydrogen is not clear.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	0	High	High	Low potential under HWC/Noblechem should mitigate problem	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.17

Cap SS 304, 308/L Weld, and HAZ
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
74

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good field experience. Unlikely to experience fatigue loading.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Any impact from crevice corrosion?	
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Low	High	High	Uncertain source of cyclic loading. Good plant experience	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.17

Cap SS 304, 308/L Weld, and HAZ
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
74

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	an issue if subjected to cyclic stresses	
4	Low	High	High	Good field experience. Unlikely to experience fatigue loading.	
5	Low	Medium	High	Little difference expected between NWC and HWC for this location/environment/degradation mechanism	
6	Medium	Medium	Medium	Mechanism is not clear yet and need more study for quantitative interpretation.	Role of hydrogen should be studied from a mechanistic point of view.
7	Low	Medium	Medium	Depends on configuration and stressing	
8	0	High	High	Environmental effect dependent on loading conditions, but will be mitigated by HWC/Noblechem	

Subgroup **9.17**

Cap SS 304, 308/L Weld, and HAZ
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
74

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Some concern for HAZ	
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects, thermal aging
3	Low	High	High	can be a concern as an initiation site for SCC; not common at these temperatures	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem	Not for the 304 base metal.
5	Low	Medium	Medium	Lack of in-environment FR test data	
6	Low	High	High	J-R curves may be affected by environments.	LTA hardening may affect FR
7	Low	Medium	Medium	Depends on configuration and stressing	
8	Medium	High	Medium	Concern about degree of constraint, lack of data in environment and thermal aging of duplex 308L	

Subgroup **9.17**

Cap SS 304, 308/L Weld, and HAZ
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
74

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for SCC in HAZ	
2	Medium	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization in HAZ, cold work and water quality. Duplex structure of weld metal less susceptible	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	possible if highly stressed and sensitized	
4	Low	High	High	C content, cold work and historically poor chemistry aggravating factors.	Not for the 304 base metal.
5	Medium	High	High	HAZ is highly susceptible	
6	Low	High	High	SCC susceptibility depends upon a ferrite content and there is a recommendation level. High content has been believed to be better but recent BWR core shroud crack showed that crack grew along/in the ferrite after LTA. Need more research on SCC on aged 308/L weld metal. Sensitization is also concern.	LTA should be considered.
7	Medium	Medium	Medium		
8	Medium	High	High	Well recognized problem with susceptibility as a function of material environment and stress well characterized.	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.17**

Cap SS 304, 308/L Weld, and HAZ
550 F, 1265 psia (design)
Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)

Applies to BNL Part #s with prefix RECIRC
74

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC, depends on cold work and water quality. Duplex structure of weld metal less susceptible	Stress, metallurgical condition, water quality, periods without HWC, oxidation potential
3	Low	High	High	possible if highly stressed and sensitized; assumes HWC effective otherwise susc. 2	
4	Low	High	High	C content, cold work and historically poor chemistry aggravating factors.	Not for the 304 base metal.
5	Low	High	High	HWC should help here	
6	Medium	Medium	Medium	In terms of long term performance, hydrogen may not be beneficial. Synergy effects of LTA hardening and hydrogen is not clear.	
7	Low	Medium	Medium	Low potential, residual stresses, accelerated by crevices	
8	Low	High	High	Low potential under HWC/Noblechem should mitigate problem	

Subgroup **9.18**

Pump Casing Bolting
SA 193 GR B7
External Drywell Containment

Applies to BNL Part #s with prefix RECIRC
89

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	Medium	Medium	Low risk of crevice corrosion but depends on risk of being wetted with poor quality water	Risk of wetting and water quality
3	Low	High	High	unlikely here but a concern if flanged surfaces can be wetted	
4	Low	High	High	Geometrical crevice.	
5	Low	Medium	Medium	Low risk of crevice corrosion unless wetted with poor quality water	
6	Low	High	High	Leak can provide a condition for CREV	Leak
7	Low	Medium	Medium	In oxygenated environment crevice corrosion can be expected	
8	0	High	High	Very unlkelyunder normal operating conditions when component should be dry	

Group
9

Reactor Coolant System

Reactor Recirculation System

Subgroup
9.18

Pump Casing Bolting
SA 193 GR B7
External Drywell Containment

Applies to BNL Part #s with prefix RECIRC
89

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of significant fatigue loading	
2	Low	High	High	Design issue mainly	Fatigue loading in practice
3	Medium	High	High	bolting always susceptible to fatigue if subjected to high cyclic stresses	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Not aware of significant fatigue loading	
6	Low	High	High	Any impact from crevice corrosion?	
7	Low	Medium	Medium	Dry	
8	Low	High	High	Uncertain source of cyclic loading. Good plant experience	

Group **9** **Reactor Coolant System** **Reactor Recirculation System**

Subgroup **9.18** Pump Casing Bolting
SA 193 GR B7
External Drywell Containment

Applies to BNL Part #s with prefix RECIRC
89

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	0	High	High	Not an issue in air	Material selection to ensure adequate toughness and resistance to hydrogen embrittlement if wetted when cold
3	Low	High	High	possible if highly stressed	
4	Low	High	High	Good field experience.	
5	Low	High	High	Probably somewhat susceptible	
6	Low	High	High	Normally less sensitive to SCC except Hydrogen effects when wetted.	
7	Low	Medium	Medium	Dry	
8	Low	High	High	possible if moist environment and YS specs are grossly exceeded. Not a common occurrence	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	Inadequate supports
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor water quality.	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	General corrosion must occur under these uncontrolled conditions	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	poor water quality, oxygenated.
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High	Poor quality suppression pool water a risk	
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High	Correlation between pitting and MIC	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	Cold work, welds,
8	Low	High	High	Assuming poor quality in suppression pool	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor water quality.	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	General corrosion must occur under these uncontrolled conditions	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High	Correlation between pitting and MIC	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
1-5,8-18,21-30,33-34,38-41,43-49,52-56,63-65,78-83,86-88,90-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Medium	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	High	High	Assuming poor quality in suppression pool	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
19-20,35-37,59-61,68-70

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
19-20,35-37,59-61,68-70

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used, but generic problem for sockolets.	
5	Low	Medium	High	Severe vibratory loads unlikely since ECCS is rarely used	
6	Low	High	High	Fatigue may minor since ECCS is rarely used	Cyclic stress
7	Low	Medium	Medium	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. Low temperature and low usage	
8	Low	High	High	Fatigue may minor since ECCS is rarely used	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
19-20,35-37,59-61,68-70

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor water quality.	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Low	High	High		

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
19-20,35-37,59-61,68-70

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
19-20,35-37,59-61,68-70

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
19-20,35-37,59-61,68-70

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Medium	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Assuming poor quality in suppression pool	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.4

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
6-7,31-32,42,50-51,57-58,62,66-67,71

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.4

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
6-7,31-32,42,50-51,57-58,62,66-67,71

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue may minor since ECCS is rarely used	Cyclic stress
7	Low	High	High	The valves do not appear especially prone to large cyclic loading.	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.4

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
6-7,31-32,42,50-51,57-58,62,66-67,71

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor water quality.	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	General corrosion must occur under these uncontrolled conditions	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.4

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
6-7,31-32,42,50-51,57-58,62,66-67,71

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.4

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
6-7,31-32,42,50-51,57-58,62,66-67,71

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High	Correlation between pitting and MIC	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.4**

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
6-7,31-32,42,50-51,57-58,62,66-67,71

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Assuming poor quality in suppression pool	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.5**

Flange & Bolts at strainer
Carbon Steel (including higher strength bolts) in galvanic contact with SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Assuming poor quality in suppression pool and galvanic contact with SS	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Medium	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	High	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable. Crevices present in screens and in bolt assemblies.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.5**

Flange & Bolts at strainer
Carbon Steel (including higher strength bolts) in galvanic contact with SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue may be minor since ECCS is rarely used	
6	Low	High	High	Fatigue may minor since ECCS is rarely used	Cyclic stress
7	Medium	High	High	High strength bolts are especially prone to SCC; strainers are expected to consist of highly cold worked wire elements.	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.5**

Flange & Bolts at strainer
Carbon Steel (including higher strength bolts) in galvanic contact with SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Assuming poor quality in suppression pool and galvanic contact with SS	Depends on water quality
3	Low	High	High	Geometric crevices or under-deposit	
4	Low	High	High	Poor water quality.	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	High	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	General corrosion must occur under these uncontrolled conditions	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.5**

Flange & Bolts at strainer
Carbon Steel (including higher strength bolts) in galvanic contact with SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.5**

Flange & Bolts at strainer
Carbon Steel (including higher strength bolts) in galvanic contact with SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool and galvanic contact with SS	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen. The pitting will increase the proneness to SCC.	
8	Medium	High	High	Correlation between pitting and MIC	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.5**

Flange & Bolts at strainer
Carbon Steel (including higher strength bolts) in galvanic contact with SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Medium	High	Medium	Assuming poor quality in suppression pool and galvanic contact with SS	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Assuming poor quality in suppression pool	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.6**

Strainer & Flange Parts
Type 304 SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Low	Medium	Medium	Crevice corrosion less likely than for CS. Depends on water chemistry and oxygen.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.6**

Strainer & Flange Parts
Type 304 SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue may be minor since ECCS is rarely used	
6	Low	High	High	Fatigue may minor since ECCS is rarely used	Cyclic stress
7	Low	High	High	Fatigue of SS not so intense for stainless steel partly because of lack of so much pitting.	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.6**

Strainer & Flange Parts
Type 304 SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	MIC is probable even in SS but the conditions are not certain.	
8	Medium	High	High	Correlation between pitting and MIC	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.6**

Strainer & Flange Parts
Type 304 SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor water quality in suppression pool water	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Medium	Medium	High	Likely in stainless at this temperature if water quality is poor	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	In these environments, pitting of SS can occur.	
8	Medium	High	High	Correlation between pitting and MIC	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.6**

Strainer & Flange Parts
Type 304 SS
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
93-96

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	SCC unlikely at this low temperature, despite poor water quality in the suppression pool.	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Low	High	High	At these temperatures, SCC of SS less intense but can occur if there are means for concentration	
8	Low	High	High	Assuming poor quality in suppression pool	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Potential concern in geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Low	Medium	High	Possible given the fact that crevices do exist at flanges, but offset by fact that degree of oxidizing conditions will be limited in time in stagnant water /carbon steel system	

Subgroup
10.7

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used but effect of oxygen on low frequency corrosion fatigue anticipated	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, since system is normally stagnant	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on temperature loading and frequency. Fatigue damage is probable	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	Medium	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Possibly less than NWC	
8	Low	High	High		

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.7

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Low	Medium	Medium	Assume sterilized from time to time at high temperature	Depends on water quality when stagnant and time at low temperature
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Low	Medium	Medium	Operation at high temperature will sterilize	Quality of stagnant water and length of interval between periods of high-temperature operation
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Low	Medium	High	Unlikely, given fact that temperature will be high at given times. Lower confidence value mirrors lack of information on time at temperature and source of nutrients	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated static environments can produce pitting.	
8	Medium	High	High	Only at the lower temperatures	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when highly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	C-steel is not very susceptible under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs over a broad temperature range and stagnant water is uncertain in its chemistry	
8	Low	High	High	Unlikely at low potentials	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.7

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Presence of hydrogen beneficial	Efficiency of HWC system
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	High	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	In the region where high stresses can occur	
8	Low	High	High	Very unlikely	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.8

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Potential concern in geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Low	Medium	High	Possible given the fact that crevices do exist at flanges, but offset by fact that degree of oxidizing conditions will be limited in time in stagnant water /carbon steel system	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used but effect of oxygen on low frequency corrosion fatigue anticipated	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, since system is normally stagnant	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on temperature loading and frequency. Fatigue damage is probable	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	Medium	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Possibly less than NWC	
8	Low	High	High		

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.8

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Low	Medium	Medium	Assume sterilized from time to time at high temperature	Depends on water quality when stagnant and time at low temperature
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Low	Medium	Medium	Operation at high temperature will sterilize	Quality of stagnant water and length of interval between periods of high-temperature operation
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Low	Medium	High	Unlikley, given fact that temperature will be high at given times. Lower confidence value mirrors lack of information on time at temperature and source of nutrients	

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated static environments can produce pitting.	
8	Medium	High	High	Only at the lower temperatures	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.8

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when highly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	C-steel is not very susceptible under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs over a broad temperature range and stagnant water is uncertain in its chemistry	
8	Low	High	High	Unlikely at low potentials	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.8

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix LPCS
73-77
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Presence of hydrogen beneficial	Efficiency of HWC system
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	High	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	In the region where high stresses can occur	
8	Low	High	High	Very unlikely	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.9

Valves
SA105,106,216,234 - Carbon Steel
100-200°F stagnant reactor water
HWC unimportant here (low temp)

Applies to BNL Part #s with prefix LPCS
72

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Potential concern in geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Low	Medium	High	Possible given the fact that crevices do exist at flanges, but offset by fact that degree of oxidizing conditions will be limited in time in stagnant water /carbon steel system	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.9

Valves
SA105,106,216,234 - Carbon Steel
100-200°F stagnant reactor water
HWC unimportant here (low temp)

Applies to BNL Part #s with prefix LPCS
72

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue may minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue may minor since ECCS is rarely used	
6	Low	High	High	Fatigue may minor since ECCS is rarely used	
7	Low	High	High	The valves do not appear especially prone to large cyclic loading.	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.9

Valves
SA105,106,216,234 - Carbon Steel
100-200°F stagnant reactor water
HWC unimportant here (low temp)

Applies to BNL Part #s with prefix LPCS
72
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool water. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Medium	High	High	Assumes poor quality water and availability of nutrients	Water quality including control of nutrients
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Low	Medium	High	Lower confidence value mirrors lack of information on source of nutrients	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.9

Valves
SA105,106,216,234 - Carbon Steel
100-200°F stagnant reactor water
HWC unimportant here (low temp)

Applies to BNL Part #s with prefix LPCS
72
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **10** **Emergency Core Cooling System** **Low Pressure Core Spray**

Subgroup **10.9**

Valves
SA105,106,216,234 - Carbon Steel
100-200°F stagnant reactor water
HWC unimportant here (low temp)

Applies to BNL Part #s with prefix LPCS
72
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk in low temperature, reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	C-steel is not very susceptible under these conditions	
6	Low	High	High	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	cracking unlikely in comparison to pitting/blunting	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.10

LPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
84-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.10

LPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
84-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue may be minor since ECCS is rarely used	
6	Low	High	High	Fatigue may minor since ECCS is rarely used	
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	High	High	Fatigue may minor since ECCS is rarely used	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.10

LPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
84-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor water quality.	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Certainly possible under defined O2 condition	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.10

LPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
84-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.10

LPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
84-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool water	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor water quality.	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group
10

Emergency Core Cooling System

Low Pressure Core Spray

Subgroup
10.10

LPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix LPCS
84-92

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants) - assume O2 present. Operates at ~300 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Assuming poor quality in suppression pool water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Not likely at low temps	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	Inadequate supports
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Susceptibility raised to account for O2 and low temp	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	poor water quality, oxygenated.
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	Cold work, welds,
8	Low	High	High	Assuming poor quality in suppression pool	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Susceptibility raised to account for O2 and low temp	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
1-8,15-18,20-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Once-demineralized but no water treatment. InefficientlyN2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Medium	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	High	High	Assuming poor quality in suppression pool	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
11-13,57-58

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
11-13,57-58

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used, but generic problem for sockolets.	
5	Low	Medium	High	Severe vibratory loads unlikely since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
11-13,57-58

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Susceptibility raised to account for O2 and low temp	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
11-13,57-58

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
11-13,57-58

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.3**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
11-13,57-58

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Medium	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Assuming poor quality in suppression pool	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.4** Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
9-10,14,19,34,48,60-61,68

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.4**

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
9-10,14,19,34,48,60-61,68

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	The valves do not appear especially prone to large cyclic loading.	
8	Low	High	High	Fatigue may minor since ECCS is rarely used	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.4**

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
9-10,14,19,34,48,60-61,68

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Susceptibility raised to account for O2 and low temp	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.4**

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
9-10,14,19,34,48,60-61,68

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.4**

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
9-10,14,19,34,48,60-61,68

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.4**

Valves
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
9-10,14,19,34,48,60-61,68

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1 and Mark 2, which are most plants); assume O2present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming poor quality in suppression pool	
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Assuming poor quality in suppression pool	
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Assuming poor quality in suppression pool	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Potential concern in geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Medium	High	High	Crevice geometry present in flanges, plus periodic make up of relatively impure inefficiently deoxygenated SP water	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used but effect of oxygen on low frequency corrosion fatigue anticipated	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, since system is normally stagnant	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on temperature loading and frequency. Fatigue damage is probable	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	Medium	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Possibly less than NWC	
8	Low	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Low	Medium	Medium	Assume sterilized from time to time at high temperature	Depends on water quality when stagnant and time at low temperature
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Low	Medium	Medium	Operation at high temperature will sterilize	Quality of stagnant water and length of interval between periods of high-temperature operation
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Medium	Medium	High	Possible due to periodic presence of impure SP water. Uncertainty due to time at temperature	

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water except at inclusions	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated static environments can produce pitting.	
8	Medium	High	High	Only at the lower temperatures	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when highly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	C-steel is not very susceptible under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs over a broad temperature range and stagnant water is uncertain in its chemistry	
8	Low	High	High	Unlikely at low potentials and at low temp range	

Subgroup **11.5**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Presence of hydrogen beneficial	Efficiency of HWC system
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	High	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	In the region where high stresses can occur	
8	Low	High	High	Very unlikely	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Potential concern in geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Medium	High	High	Crevice geometry present in flanges, plus periodic make up of relatively impure inefficiently deoxygenated SP water	

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used but effect of oxygen on low frequency corrosion fatigue anticipated	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, since system is normally stagnant	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on temperature loading and frequency. Fatigue damage is probable	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	Medium	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Possibly less than NWC	
8	Low	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Low	Medium	Medium	Assume sterilized from time to time at high temperature	Depends on water quality when stagnant and time at low temperature
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Low	Medium	Medium	Operation at high temperature will sterilize	Quality of stagnant water and length of interval between periods of high-temperature operation
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Medium	Medium	High	Possible due to periodic presence of impure SP water. Uncertainty due to time at temperature	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water except at inclusions	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated static environments can produce pitting.	
8	Medium	High	High	Only at the lower temperatures	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when highly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	C-steel is not very susceptible under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs over a broad temperature range and stagnant water is uncertain in its chemistry	
8	Low	High	High	Unlikely at low potentials and at low temp range	

Subgroup **11.6**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-SP
69-74
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Presence of hydrogen beneficial	Efficiency of HWC system
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
5	Low	High	High	No impact of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	In the region where high stresses can occur	
8	Low	High	High	Very unlikely	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.7**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
75-78

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	Geometric crevices or under-deposit	
4	Medium	High	High	Crevices will be formed under deposit.	
5	Low	Medium	High	Geometric crevices or under-deposit	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.7**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
75-78

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue may minor since ECCS is rarely used	
4	Low	High	High	Fatigue may minor since ECCS is rarely used	
5	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.7**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
75-78

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
5	Low	Medium	High	Likely as oxygen is present	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Susceptibility raised to account for O2 and low temp	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.7**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
75-78

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
4	Medium	High	High	Assuming poor water quality in the suppression pool. Periodic flushing aggravates MIC.	
5	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.7**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
75-78

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor quality in suppression pool water	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	Medium	High	Possible but probably not a major concern	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group **11** **Emergency Core Cooling System** **High Pressure Core Spray - SP Water**

Subgroup **11.7**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Suppression pool water for cooling, typically <100°F

Applies to BNL Part #s with prefix HPCS-SP
75-78

Notes: Once-demineralized but no water treatment; inefficiently N2 blanked (only in Mark 1 and Mark 2,which are most plants) - assume O2 present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality can be poor. MIC certainly possible. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Assuming poor quality in suppression pool water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Assuming poor water quality in the suppression pool	
5	Low	High	High	Assuming poor quality in suppression pool	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Not likely at low temps	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	Medium	Assuming air saturated CST water	Geometric crevices, presence of deposits, water quality
3	Low	High	High	Geometric crevices or under-deposit would be a concern in air-saturated parts of the line (close to condensate storage tank)	
4	Medium	High	High	Geometric crevices possible.	
6	Medium	High	High	Geometric crevices or under-deposit	
7	High	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	Medium	High	Geometric crevices or under-deposit	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses, System not extensively used.	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	CO2 and O2 will accelerate GC a bit	
2	Low	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	generally low but higher near condensate storage tank ends of the line	
4	Low	High	High	Poor quality water	
6	Low	High	High	Possible degradation in oxygenated water	
7	High	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	High	Susceptibility raised to account for O2& CO2 and low temp	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some chance of MIC, but introduction of MIC into system is limited and pure water+CO2 is limited nutrient supply -- limited effect expected.	
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Medium	High	High	risk of MIC since water exposed to air and periodically flushed, which introduces fresh nutrients	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	High	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	. Flushing ~3 months aggravates MIC.	

Subgroup
11A.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming air saturated CST water	Water quality
3	Medium	High	High	most likley in areas close to condensate storage tank where water is air-saturated	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	High	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.1

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water apart from O2 and CO2	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality and residual stress
3	Low	High	High	Assuming high quality CST water, which becomes deaerated (by carbon steel corrosion) during stagnant times	
4	Low	High	High	SCC unlikely at this low temperature.	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	Medium	Assuming air saturated CST water	Geometric crevices, presence of deposits, water quality
3	Low	High	High	Geometric crevices or under-deposit would be a concern in air-saturated parts of the line (close to condensate storage tank)	
4	Medium	High	High	Geometric crevices possible.	
6	Medium	High	High	Geometric crevices or under-deposit	
7	High	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	Medium	High	Geometric crevices or under-deposit	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. System not extensively used.	
8	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	CO2 and O2 will accelerate GC a bit	
2	Low	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	generally low but higher near condensate storage tank ends of the line	
4	Low	High	High	Poor quality water	
6	Low	High	High	Possible degradation in oxygenated water	
7	High	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	High	Susceptibility raised to account for O2 &CO2 and low temp	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some chance of MIC, but introduction of MIC into system is limited and pure water+CO2 is limited nutrient supply -- limited effect expected.	
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Medium	High	High	risk of MIC since water exposed to air and periodically flushed, which introduces fresh nutrients	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	High	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Flushing ~3 months aggravates MIC.	

Subgroup
11A.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming air saturated CST water	Water quality
3	Medium	High	High	most likley in areas close to condensate storage tank where water is air-saturated	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	High	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.2

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
1-8,15-18,20-21,23-33,35-47,49-56,59,62-67,70-74,79-83

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality and residual stress
3	Low	High	High	Assuming high quality CST water, which becomes deaerated (by carbon steel corrosion) during stagnant times	
4	Low	High	High	Poor quality water	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	High	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	High	High		

Subgroup
11A.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
11-13,57-58

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	Medium	Assuming air saturated CST water	Geometric crevices, presence of deposits, water quality
3	Low	High	High	Geometric crevices or under-deposit would be a concern in air-saturated parts of the line (close to condensate storage tank)	
4	Medium	High	High	Geometric crevices possible.	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	Medium	High	Geometric crevices or under-deposit	

Subgroup
11A.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
11-13,57-58

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. However, these systems are not extensively used.	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
11-13,57-58

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	CO2 and O2 will accelerate GC a bit	
2	Low	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	generally low but higher near condensate storage tank ends of the line	
4	Low	High	High	Poor quality water	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	High	Susceptibility raised to account for O2&CO2 and low temp	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
11-13,57-58

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some chance of MIC, but introduction of MIC into system is limited and pure water+CO2 is limited nutrient supply -- limited effect expected.	
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Medium	High	High	risk of MIC since water exposed to air and periodically flushed, which introduces fresh nutrients	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	. Flushing ~3 months aggravates MIC.	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
11-13,57-58

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming air saturated CST water	Water quality
3	Medium	High	High	most likley in areas close to condensate storage tank where water is air-saturated	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.3

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
11-13,57-58

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality and residual stress
3	Low	High	High	Assuming high quality CST water, which becomes deaerated (by carbon steel corrosion) during stagnant times	
4	Low	High	High	Poor quality water	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.4

Valves
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
9-10,14,19,34,48,60-61,68

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	Medium	Assuming air saturated CST water	Geometric crevices, presence of deposits, water quality
3	Low	High	High	Geometric crevices or under-deposit would be a concern in air-saturated parts of the line (close to condensate storage tank)	
4	Medium	High	High	Geometric crevices possible.	
6	Medium	High	High	Geometric crevices or under-deposit	
7	High	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	Medium	High	Geometric crevices or under-deposit	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.4

Valves
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
9-10,14,19,34,48,60-61,68

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	The valves do not appear especially prone to large cyclic loading.	
8	Low	High	High	Fatigue may minor since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.4

Valves
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
9-10,14,19,34,48,60-61,68

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	CO2 and O2 will accelerate GC a bit	
2	Low	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	generally low but higher near condensate storage tank ends of the line	
4	Low	High	High	Poor quality water	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	High	Susceptibility raised to account for O2 &CO2 and low temp	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.4

Valves
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
9-10,14,19,34,48,60-61,68

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some chance of MIC, but introduction of MIC into system is limited and pure water+CO2 is limited nutrient supply -- limited effect expected.	
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Medium	High	High	risk of MIC since water exposed to air and periodically flushed, which introduces fresh nutrients	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Flushing ~3 months aggravates MIC.	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.4

Valves
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
9-10,14,19,34,48,60-61,68

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming air saturated CST water	Water quality
3	Medium	High	High	most likley in areas close to condensate storage tank where water is air-saturated	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.4

Valves
SA105,106,216,234 - Carbon Steel
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
9-10,14,19,34,48,60-61,68

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality and residual stress
3	Low	High	High	Assuming high quality CST water, which becomes deaerated (by carbon steel corrosion) during stagnant times	
4	Low	High	High	Poor quality water	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Medium	High	High	Crevice geometry present in flanges, plus periodic make up of relatively inefficiently deoxygenated CST water	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used but effect of oxygen on low frequency corrosion fatigue anticipated	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Medium	High	High	Risk for thermal fatigue.	Fatigue loading assumed minor since ECCS is rarely used
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on temperature loading and frequency. Fatigue damage is probable	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Possibly less than NWC	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Low	High	High	Assume sterilized from time to time at high temperature	Depends on water quality when stagnant and time at low temperature
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Low	Medium	Medium	Operation at high temperature will sterilize	Quality of stagnant water and length of interval between periods of high-temperature operation
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Low	Medium	High	Possible due to periodic presence of relatively oxygenated CST water. Uncertainty due to time at temperature and degree of impurity in CST water	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water except at inclusions	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Stagnant water.	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated static environments can produce pitting.	
8	Medium	High	High	Only at the lower temperatures	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when higly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Possible if initiated by pitting.	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs over a broad temperature range and stagnant water is uncertain in its chemistry	
8	Low	High	High	Unlikely at low potentials and at low temp range	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.5

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Presence of hydrogen beneficial	Efficiency of HWC system
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	In the region where high stresses can occur	
8	Low	High	High	Very unlikely	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice corrosion.	
2	Low	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	creviced areas subject to crevice corrosion if area can be wetted	
4	Low	High	High	Possible if cracks form in deposits.	
5	Low	High	High	Could occur in geometric crevices or under deposits	Water quality
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	In oxygenated environments CREV occurs for carbon steels	
8	Medium	High	High	Crevice geometry present in flanges, plus periodic make up of relatively inefficiently deoxygenated CST water	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used but effect of oxygen on low frequency corrosion fatigue anticipated	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Medium	High	High	Risk for thermal fatigue.	Fatigue loading assumed minor since ECCS is rarely used
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	Medium	Medium	Depends on temperature loading and frequency. Fatigue damage is probable	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor, since ECCS is rarely used	Cyclic loading
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Possibly less than NWC	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	In high quality reactor water, expect little crevice MIC.	
2	Low	High	High	Assume sterilized from time to time at high temperature	Depends on water quality when stagnant and time at low temperature
3	Medium	High	High	a concern in stagnant systems with occasional flushing	
4	Low	High	High	Should not be a problem in reactor quality water even if stagnant.	
5	Low	Medium	Medium	Operation at high temperature will sterilize	Quality of stagnant water and length of interval between periods of high-temperature operation
6	Low	High	High	Possible degradation in stagnant.	
7	Medium	Medium	Medium	The lower part of this temperature range will support MIC especially in stagnant water	
8	Low	Medium	High	Possible due to periodic presence of relatively oxygenated CST water. Uncertainty due to time at temperature and degree of impurity in CST water	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Low risk in reactor quality water except at inclusions	Depends on water quality
3	Medium	High	High	a concern in aerated parts	
4	Medium	High	High	Stagnant water.	
6	Low	High	High	Possible and need to clarify a significance in SCC initiation	Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygenated static environments can produce pitting.	
8	Medium	High	High	Only at the lower temperatures	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANTS)

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when higly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High		
4	Low	High	High	Possible if initiated by pitting.	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs over a broad temperature range and stagnant water is uncertain in its chemistry	
8	Low	High	High	Unlikely at low potentials and at low temp range	

Subgroup
11A.6

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA106,234 - Carbon Steel
100-550°F stagnant reactor water

Applies to BNL Part #s with prefix HPCS-CST
69-74
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Presence of hydrogen beneficial	Efficiency of HWC system
3	Low	High	High		
4	Low	High	High	No effect of HWC since only at higher temperature part of the time and the remainder of the time the water is stagnant so HWC cannot be maintained.	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	In the region where high stresses can occur	
8	Low	High	High	Very unlikely	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.7

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
75-78

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Geometric crevices or under-deposit	
2	Medium	High	Medium	Assuming air saturated CST water	Geometric crevices, presence of deposits, water quality
3	Low	High	High	Geometric crevices or under-deposit would be a concern in air-saturated parts of the line (close to condensate storage tank)	
4	Medium	High	High	Geometric crevices possible.	
6	Medium	High	High	Geometric crevices or under-deposit	
7	High	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	Medium	High	Geometric crevices or under-deposit	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.7

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
75-78

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue may minor since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	Medium	High	Fatigue may minor since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.7

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
75-78

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	CO2 and O2 will accelerate GC a bit	
2	Low	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	generally low but higher near condensate storage tank ends of the line	
4	Low	High	High	Poor quality water	
6	Low	High	High	Possible degradation in oxygenated water	
7	High	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	High	Susceptibility raised to account for O2&CO2 and low temp	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.7

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
75-78

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some chance of MIC, but introduction of MIC into system is limited and pure water+CO2 is limited nutrient supply -- limited effect expected.	
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Low	High	High	risk of MIC since water exposed to air and periodically flushed, which introduces fresh nutrients	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	High	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Flushing ~3 months aggravates MIC.	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.7

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
75-78

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	most likley in areas close to condensate storage tank where water is air-saturated	
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Likely in oxygenated water with CL	Surface finish, Geometry and deposit of corrosion product
7	High	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	Medium	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.7

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
75-78

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality and residual stress
3	Low	High	High	Assuming high quality CST water, which becomes deaerated (by carbon steel corrosion) during stagnant times	
4	Low	High	High	Poor quality water	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Not likel at low temps	

Subgroup
11A.8

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
Type 304 SS Base Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
22 andother unlisted parts

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Fatigue of SS not so intense for stainless steel partly because of lack of so much pitting. Also, this system is not extensively used.	
8	Low	Medium	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.8

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
Type 304 SS Base Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
22 andother unlisted parts

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Some chance of MIC, but introduction of MIC into system is limited and pure water+CO2 is limited nutrient supply -- limited effect expected.	
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Low	High	High		
4	Medium	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	MIC is probable even in SS but the conditions are not certain.	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.8

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
Type 304 SS Base Metal
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
22 andother unlisted parts

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality
3	Low	High	High	Assuming high quality CST water	
4	Low	High	High	SCC unlikely at this low temperature despite poor quality water.	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Low	High	High	At these temperatures, SCC of SS less intense but can occur if there are means for concentration	
8	Low	High	High	Unlikely at this low temperature	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.9

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
Type 304 SS Weld Metal & HAZ
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
22 andother unlisted parts

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
2	Low	High	High	Fatigue loading assumed minor, especially since ECCS is rarely used	Cyclic loading, weld defects
3	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	
4	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	
6	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	Cyclic stress
7	Low	High	High	Fatigue of SS not so intense for stainless steel partly because of lack of so much pitting. Also, this system is not extensively used.	
8	Low	High	High	Fatigue loading assumed minor, esp. since ECCS is rarely used	

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.9

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
Type 304 SS Weld Metal & HAZ
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
22 andother unlisted parts

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	Medium	Medium	Assuming air saturated CST water but low in nutrients	Water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
6	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	
7	Medium	Medium	Medium	MIC is probable even in SS but the conditions are not certain.	
8	Low	High	High		

Group
11A

Emergency Core Cooling System

HPCS - CST Water (OTHER PLANT)

Subgroup
11A.9

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
Type 304 SS Weld Metal & HAZ
Condensate storage water for cooling, typ. <100°F

Applies to BNL Part #s with prefix HPCS-CST
22 andother unlisted parts

Notes: Demineralized, vented to atmosphere so O2 is present. Operates at ~1100 psi when active. Always wetted from "keep-fill system"; water quality is good. MIC relatively unlikely. Flushed ~3 months.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Assuming high quality CST water	
2	Medium	High	Medium	Assuming air saturated CST water	Water quality,residual stress, low temperature
3	Low	High	High	Assuming high quality CST water	
4	Low	High	High	SCC unlikely at this low temperature.	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Low	High	High	At these temperatures, SCC of SS less intense but can occur if there are means for concentration	
8	Medium	High	High	Assuming high quality CST water, susceptibilty ranking increased assuming that intermediate 2 ppm O2 is possible	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
1,3,4C
Notes: Stagnant Wet Steam - HWC not beneficial

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
2	Low	High	Medium	Thermal eddies or flow induced vibration in deadlegs	Cyclic loading
3	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
4	Low	High	Medium	Stagnant conditions most of the time.	
5	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
6	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	Strain rate and number of cycles
7	Medium	Medium	Medium	Thermal effects and long pipe and elbow.	
8	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
1,3,4C

Notes: Stagnant Wet Steam - HWC not beneficial

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Oxidizing environment in steam condensate	Water quality
3	Low	High	High		
4	Low	High	High	Oxidizing environment in steam condensate. May decrease with time as oxygen consumed.	
5	Low	High	High	Probably possible but unlikely to be dominant here	
6	Low	High	High	oxidizing environment in steam condensate	Potential and steam chemistry
7	Medium	Medium	Medium	GC can occur in this environment	
8	Low	High	High		

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
1,3,4C

Notes: Stagnant Wet Steam - HWC not beneficial

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	oxidizing environment in steam condensate	
2	Low	High	High	Oxidizing environment in steam condensate	Water quality
3	Medium	Medium	Medium	oxidizing environment in steam condensate	
4	Low	Medium	Medium	Oxidizing environment in steam condensate.	
5	Low	Medium	Medium	oxidizing environment in steam condensate	
6	Low	Medium	Medium	oxidizing environment in steam condensate	Potential and steam chemistry
7	Medium	Medium	Medium	Pitting can occur in the oxygenated environment	
8	Low	Medium	Medium	oxidizing environment in steam condensate	

Subgroup **12.1**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
1,3,4C

Notes: Stagnant Wet Steam - HWC not beneficial

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Low	High	High		
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	High	High	Carbon steels is susceptibl to SCC even wet steam as well as water.	Water impurities
7	Medium	Medium	Medium	SCC reasonable in these oxygen and cold work elbow conditions	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress. Lowered confidence value mirrors the possible effect of dynamic strains	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4B,4,2
Notes: Stagnant Wet Steam - HWC not beneficial

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
2	Low	High	Medium	Thermal eddies or flow induced vibration in deadlegs	Cyclic loading and weld defects
3	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
4	Low	High	Medium	Stagnant conditions most of the time.	
5	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
6	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	Strain rate and number of cycles
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	

Subgroup **12.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4B,4,2
Notes: Stagnant Wet Steam - HWC not beneficial

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Oxidizing environment in steam condensate	Water quality
3	Low	High	High		
4	Low	High	High	Oxidizing environment in steam condensate. May decrease with time as oxygen consumed.	
5	Low	High	High	Probably possible but unlikely to be dominant here	
6	Low	High	High	oxidizing environment in steam condensate	Potential and steam chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Low	High	High		

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4B,4,2

Notes: Stagnant Wet Steam - HWC not beneficial

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	oxidizing environment in steam condensate	
2	Low	High	High	Oxidizing environment in steam condensate	Water quality
3	Medium	Medium	Medium	oxidizing environment in steam condensate	
4	Low	Medium	Medium	Oxidizing environment in steam condensate.	
5	Low	Medium	Medium	oxidizing environment in steam condensate	
6	Low	Medium	Medium	oxidizing environment in steam condensate	Potential and steam chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium	oxidizing environment in steam condensate	

Subgroup **12.2**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4B,4,2
Notes: Stagnant Wet Steam - HWC not beneficial

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Greater concern for weld metal and HAZ, but not quite "2"	
2	Medium	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high, particularly in HAZ.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Medium	High	High	Assuming not stress relieved.	
5	Medium	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high (e.g., HAZ).	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	Medium	High	Possible degradation in stagnant stean. Accelerated oxidation can be a mechanism of SCC	Weld residual stress and hardening
7	Medium	Medium	Medium	SCC reasonable in these oxygen and cold work elbow conditions	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress. Lowered confidence value mirrors the possible effect of dynamic strains	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.3**

Weldolets and Sockolets
SA105 - Carbon Steel Base & Weld
Stagnant Wet Steam - HWC not beneficial
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4A
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	High		
2	Medium	High	Medium	Flow induced vibration in deadlegs	Cyclic loading, socket weld design, fabrication defects
3	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	
4	Medium	High	Medium	Stagnant conditions most of the time.	Generic problems with sockolets.
5	Medium	Medium	Medium	Thermal fatigue due to eddies in deadleg	
6	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	Strain rate and number of cycles
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Medium	High	Medium	Thermal fatigue due to eddies in deadleg	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.3**

Weldolets and Sockolets
SA105 - Carbon Steel Base & Weld
Stagnant Wet Steam - HWC not beneficial
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4A
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Oxidizing environment in steam condensate	Water quality
3	Low	High	High		
4	Low	High	High	Oxidizing environment in steam condensate. May decrease with time as oxygen consumed.	
5	Low	High	High	Probably possible but unlikely to be dominant here	
6	Low	High	High	oxidizing environment in steam condensate	Potential and steam chemistry
7	Medium	Medium	Medium	Questionable water quality and oxygen will lead to general corrosion	
8	Low	High	High		

Subgroup **12.3**

Weldolets and Sockolets
SA105 - Carbon Steel Base & Weld
Stagnant Wet Steam - HWC not beneficial
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4A
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	oxidizing environment in steam condensate	No known service problems
2	Low	High	High	Oxidizing environment in steam condensate	Water quality
3	Medium	Medium	Medium	oxidizing environment in steam condensate	No known service problems
4	Low	Medium	Medium	Oxidizing environment in steam condensate.	
5	Low	Medium	Medium	oxidizing environment in steam condensate	No known service problems
6	Low	Medium	Medium	oxidizing environment in steam condensate	Potential and steam chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, questionable steam quality, oxygen	
8	Low	Medium	Medium	oxidizing environment in steam condensate	No known service problems

Subgroup **12.3**

Weldolets and Sockolets
SA105 - Carbon Steel Base & Weld
Stagnant Wet Steam - HWC not beneficial
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
4A
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Medium	High	High	Assuming not stress relieved	
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Medium	High	High		Water impurities
7	Medium	Medium	Medium	SCC reasonable in these oxygenated and cold work elbow and welded conditions	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress. Lowered confidence value mirrors the possible effect of dynamic strains	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.4**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
6.8,9,10

Notes: Stagnant Steam Condensate - HWC not beneficial

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	decreasing thermal fatigue problem from that in steam	
2	Low	High	Medium	Thermal eddies or flow induced vibration in deadlegs	Cyclic loading
3	Low	High	Medium	decreasing thermal fatigue problem from that in steam	
4	Low	High	Medium	Stagnant conditions most of the time.	
5	Low	High	Medium	decreasing thermal fatigue problem from that in steam	
6	Low	High	Medium	decreasing thermal fatigue problem from that in steam	Strain rate and number of cycles
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	High	Medium	decreasing thermal fatigue problem from that in steam	

Subgroup **12.4**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
6.8,9,10

Notes: Stagnant Steam Condensate - HWC not beneficial

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
2	Low	High	High	Not an issue in condensate from properly controlled water chemistry	Water quality
3	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
4	Low	High	High	Less oxidising environment with possible protective oxide. May decrease with time as oxygen consumed.	
5	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
6	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
7	Medium	Medium	Medium	Questionable water quality and oxygen will lead to general corrosion	
8	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.4**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
6.8,9,10

Notes: Stagnant Steam Condensate - HWC not beneficial

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk in good quality high temperature condensate	Depends on water quality
3	Low	High	High	potential for pitting in oxygenated, stagnant , but less likely at these temperatures than at low temperatures	
4	Medium	Medium	Medium	Stagnant high temperature conditions.	
5	Low	High	High	Low risk in good quality high temperature condensate	Water quality
6	Low	High	High	geometry and deposit of corrosion products may form pits	
7	Medium	Medium	Medium	Pitting is certain owing to deposits, questionable steam quality, oxygen	
8	Low	Medium	High	Unlikely at operating temperature , but confidence value reflects that pitting may occur during uncontrolled shutdown conditions	

Subgroup **12.4**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
6.8,9,10

Notes: Stagnant Steam Condensate - HWC not beneficial

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Low	High	High		
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	Medium	High	Carbon steels is susceptibl to SCC even wet steam as well as water.	Water impurities and cold work
7	Medium	Medium	Medium	SCC reasonable in these oxygenated and cold work elbow and welded conditions	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress. Lowered confidence value mirrors the possible effect of dynamic strains	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.5**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
7,5

Notes: Stagnant Steam Condensate - HWC not beneficial

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible at lower end of line , but dependent on extent of oxygen in condensate and removal rate due to corrosion	
2	Low	High	High	Unlikely in condensate from properly controlled water chemistry	Geometrical crevices, deposits, water chemistry
3	Low	High	High	Possible at lower end of line , but dependent on extent of oxygen in condensate and removal rate due to corrosion	
4	Low	High	High	Geometric crevices possible.	
5	Low	High	High	Possible at lower end of line , but dependent on extent of oxygen in condensate and removal rate due to corrosion	
6	Low	High	High	Possible at lower end of line , but dependent on extent of oxygen in condensate and removal rate due to corrosion	Geometry and corrosion products
7	Medium	Medium	Medium	Crevices with oxygen and tight crevice geometry will produce some crevice corrosion	
8	Low	High	High	Possible at lower end of line , but dependent on extent of oxygen in condensate and removal rate due to corrosion	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.5**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
7,5

Notes: Stagnant Steam Condensate - HWC not beneficial

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Decreasing problem from that in steam	
2	Low	High	Medium	Thermal eddies or flow induced vibration in deadlegs	Cyclic loading
3	Low	High	Medium	Decreasing problem from that in steam	
4	Low	High	Medium	Stagnant conditions most of the time.	
5	Low	High	Medium	Decreasing problem from that in steam	
6	Low	High	Medium	Decreasing problem from that in steam	Strain rate and number of cycles
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	High	Medium	Decreasing problem from that in steam	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.5**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
7,5

Notes: Stagnant Steam Condensate - HWC not beneficial

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
2	Low	High	High	Not an issue in condensate from properly controlled water chemistry	Water quality
3	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
4	Low	High	High	Less oxidising environment with possible protective oxide. May decrease with time as oxygen consumed.	
5	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
6	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
7	Medium	Medium	Medium	Questionable water quality and oxygen will lead to general corrosion	
8	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems

Group
12

Auxiliary System

Reactor Core Isolation Cooling

Subgroup
12.5

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld Metal
547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
7,5

Notes: Stagnant Steam Condensate - HWC not beneficial

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible but unlikely due to lack of obvious dynamic load	
2	Low	High	High	Unlikely in condensate from properly controlled water chemistry	Water quality, residual stress
3	Low	High	High	Possible but unlikely due to lack of obvious dynamic load	
4	Low	High	High	Less oxidising environment with possible protective oxide.	
5	Low	High	High	Possible but unlikely due to lack of obvious dynamic load	
6	Low	High	High	Possible degradation in stagnant stean. Accelerated oxidation can be a mechanism of SCC	Weld residual stress
7	Medium	Medium	Medium	SCC reasonable in these oxygenated and cold work elbow and welded conditions	
8	Low	High	High	Possible but unlikely due to lack of obvious dynamic load	

Subgroup **12.6**

Valves
SA216 - Carbon Steel
Stagnant Steam Condensate - HWC not beneficial
250- 547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
12
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible, but dependent on extent of oxygen in condensate and removal rate due to corrosion	
2	Low	High	High	Unlikely in condensate from properly controlled water chemistry	Geometrical crevices, deposits, water chemistry
3	Low	High	High	Possible, but dependent on extent of oxygen in condensate and removal rate due to corrosion	
4	Low	High	High	Geometric crevices possible.	
5	Low	High	High	Possible, but dependent on extent of oxygen in condensate and removal rate due to corrosion	
6	Low	High	High	Possible, but dependent on extent of oxygen in condensate and removal rate due to corrosion	Geometry and corrosion products
7	Medium	Medium	Medium	Presence of oxygen a fitted parts support CREV	
8	Low	High	High	Possible, but dependent on extent of oxygen in condensate and removal rate due to corrosion	

Subgroup **12.6**

Valves
SA216 - Carbon Steel
Stagnant Steam Condensate - HWC not beneficial
250- 547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
12
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium	Decreasing problem from that in steam due to removal of oxygen due to corrosion	
2	Low	High	Medium	Thermal eddies or flow induced vibration in deadlegs	Cyclic loading
3	Low	High	Medium	Decreasing problem from that in steam due to removal of oxygen due to corrosion	
4	Low	High	Medium	Stagnant conditions most of the time.	
5	Low	High	Medium	Decreasing problem from that in steam due to removal of oxygen due to corrosion	
6	Low	High	Medium	Decreasing problem from that in steam due to removal of oxygen due to corrosion	Strain rate and number of cycles
7	Low	Medium	Medium	Valves are more robust and may be less likely to sustain fatigue but depends on design.	
8	Low	High	Medium	Decreasing problem from that in steam due to removal of oxygen due to corrosion	

Subgroup **12.6**

Valves
SA216 - Carbon Steel
Stagnant Steam Condensate - HWC not beneficial
250- 547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
12
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
2	Low	High	High	Not an issue in condensate from properly controlled water chemistry	Water quality
3	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
4	Low	High	High	Less oxidising environment with possible protective oxide. May decrease with time as oxygen consumed.	
5	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
6	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
7	Medium	Medium	Medium	CS sustains GC at these temperatures and oxygen	
8	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.6**

Valves
SA216 - Carbon Steel
Stagnant Steam Condensate - HWC not beneficial
250- 547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
12
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk in good quality high temperature condensate	Depends on water quality
3	Low	High	High	potential for pitting in oxygenated, stagnant , but less likely at these temperatures than at low temperatures	
4	Medium	Medium	Medium	Stagnant high temperature conditions.	
5	Low	High	High	Low risk in good quality high temperature condensate	Water quality
6	Low	High	High	geometry and deposit of corrosion products may form pits	
7	Medium	Medium	Medium	Presence of oxygen and stagnant conditions will lead to pitting.	
8	Low	Medium	High	Unlikely at operating temperature , but confidence value reflects that pitting may occur in the lower temperature region or during uncontrolled shutdown conditions	

Subgroup **12.6**

Valves
SA216 - Carbon Steel
Stagnant Steam Condensate - HWC not beneficial
250- 547°F, 1020 psia

Applies to BNL Part #s with prefix RCIC
12
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Low	High	High		
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	High	High	Carbon steels is susceptibl to SCC even wet steam as well as water.	Water impurities
7	Medium	Medium	Medium	Cold work stress and welding stresses increase the probability for SCC together with the oxygen	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress. Lowered confidence value mirrors the possible effect of dynamic strains	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
15,16,17,19,,22,24,33,35.38, 40, 46,48,49,70,72,76

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC effect here. Always wetted from "keep-fill system"; water quality is good.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Potential risk in geometric crevices or under-deposits	Depends on water quality
3	Low	High	High	some concern in tight crevices, but should decrease with consumption of oxygen by general corrosion of carbon steel.	
4	Low	High	High	Where geometrical crevices present.	
5	Low	High	High	Can occur in geometric crevices or under deposits	Water quality
6	Low	High	High	geometry and deposit of corrosion products may form pits	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Crevice geometry present in flanges, plus relatively inefficiently deoxygenated CST water	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
15,16,17,19,,22,24,33,35.38, 40, 46,48,49,70,72,76

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC effect here. Always wetted from "keep-fill system"; water quality is good.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
4	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
5	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
6	Low	High	High	Relatively protective oxide in less oxidising environment	No known service problems
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
15,16,17,19,,22,24,33,35.38, 40, 46,48,49,70,72,76

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC effect here. Always wetted from "keep-fill system"; water quality is good.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
4	Low	High	High	Unlikely due to good quality water and consumption of oxygen.	
5	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
15,16,17,19,,22,24,33,35.38, 40, 46,48,49,70,72,76

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC effect here. Always wetted from "keep-fill system"; water quality is good.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
4	Low	Medium	Medium	Possible initially but will decrease with time due to consumption of oxygen.	
5	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	

Subgroup **12.7**

Various elbows, flanges, & pipe (base metal)
Primary & secondary containment
SA105,106,216,234 - Carbon Steel
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
15,16,17,19,,22,24,33,35.38, 40, 46,48,49,70,72,76

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC effect here. Always wetted from "keep-fill system"; water quality is good.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Low	High	High	Oxygenated water part of the time.	
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	Medium	High	Carbon steels is susceptibl to SCC even wet steam as well as water.	Water impurities and cold work
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress, low temperature and relatively good purity water. Lowered confidence value mirrors the possible effect of dynamic strains in conjunction with intermediate O2 level circa 1-2 ppm	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
13,73,11,14,15,18,20,22,24,26,28,34,36,37,39,42,43,44,45,45A,47,51

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC has no benefit
Always wetted from "keep-fill system"; water quality is good.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Potential risk in geometric crevices or under-deposits	Depends on water quality
3	Low	High	High	some concern in tight crevices, but should decrease with consumption of oxygen by general corrosion of carbon steel.	
4	Low	High	High	Where geometrical crevices present.	
5	Low	High	High	Can occur in geometric crevices or under deposits	Water quality
6	Low	High	High	geometry and deposit of corrosion products may form pits	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Crevice geometry present in flanges, plus relatively inefficiently deoxygenated CST water	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
13,73,11,14,15,18,20,22,24,26,28,34,36,37,39,42,43,44,45,45A,47,51

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC has no benefit
Always wetted from "keep-fill system"; water quality is good.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
4	Medium	High	High	Initially high, decreasing with time due to consumption of oxygen.	
5	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
6	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	

Subgroup **12.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
13,73,11,14,15,18,20,22,24,26,28,34,36,37,39,42,43,44,45,45A,47,51

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC has no benefit
Always wetted from "keep-fill system"; water quality is good.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
4	Low	High	High	Unlikely due to good quality water and consumption of oxygen.	
5	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
13,73,11,14,15,18,20,22,24,26,28,34,36,37,39,42,43,44,45,45A,47,51

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC has no benefit
Always wetted from "keep-fill system"; water quality is good.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
4	Low	Medium	Medium	Possible initially but will decrease with time due to consumption of oxygen.	
5	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.8**

Welds and HAZ in various elbows, flanges, & pipe
Primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Stag. condensate water, typ. <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
13,73,11,14,15,18,20,22,24,26,28,34,36,37,39,42,43,44,45,45A,47,51

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC has no benefit
Always wetted from "keep-fill system"; water quality is good.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assuming high quality CST water and relatively low temperature	Water quality and residual stress
3	Low	Medium	High	Possible at welds at intermediate combinations of circa 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading e.g. vibration.	
4	Low	Medium	High	Possible at welds at intermediate combinations of circa 2 ppm oxygen and 200F.	Needs dynamic loading conditions.
5	Low	Medium	High	Possible at welds at intermediate combinations of circa 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading e.g. vibration.	
6	Low	Medium	High	Possible at welds at intermediate combinations of circa 2ppm oxygen and 200F. Liklihood will depend on source of applied dynamic loading e.g vibration.	Residual stress at weld and cold work in elbows
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	Medium	High	Possible at welds at intermediate combinations of circa 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading e.g. vibration.	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.9**

Weldolets, Sockolets and Tees
SA105,106,234 - Carbon Steel Base & Weld
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
23,27,52,53

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Stagnant system so source of thermal eddies/dynamic strains lacking	
2	Medium	High	Medium	No obvious source of fatigue stresses in stagnant system	Cyclic loading, socket weld design, fabrication defects
3	Low	Medium	Medium	Stagnant system so source of thermal eddies/dynamic strains lacking	
4	Low	High	Medium	Stagnant conditions most of the time.	Generic problem with sockolets.
5	Low	Medium	Medium	Stagnant system so source of thermal eddies/dynamic strains lacking	
6	Medium	Medium	Medium	Flow induced vibrations at dead legs	Can be small amplitude and very high cycles vinration
7	Medium	High	Medium	No obvious source of fatigue stresses in stagnant system	
8	Medium	Low	Medium	Stagnant system so source of thermal eddies/dynamic strains lacking	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.9**

Weldolets, Sockolets and Tees
SA105,106,234 - Carbon Steel Base & Weld
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
23,27,52,53

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
2	Low	High	High	Not an issue in condensate from properly controlled water chemistry	Water quality
3	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
4	Medium	High	High	Initially high, decreasing with time due to consumption of oxygen.	
5	Low	High	High	Initially high, decreasing with time due to decreasing oxygen content	
6	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	Potential and water chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.9**

Weldolets, Sockolets and Tees
SA105,106,234 - Carbon Steel Base & Weld
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
23,27,52,53

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
2	Low	High	High	Assuming high quality condensate water and despite intermittent flushing	Water quality
3	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
4	Low	High	High	Unlikely due to good quality water and consumption of oxygen.	
5	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	

Subgroup **12.9**

Weldolets, Sockolets and Tees
SA105,106,234 - Carbon Steel Base & Weld
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
23,27,52,53

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
4	Low	Medium	Medium	Possible initially but will decrease with time due to consumption of oxygen.	
5	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	Potential and water chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.9**

Weldolets, Sockolets and Tees
SA105,106,234 - Carbon Steel Base & Weld
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
23,27,52,53

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	High	Possible at welds at intermediate combinations of ~ 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading, e.g., vibration.	
2	Low	High	High	Assuming high quality condensate water and low temperature	Water quality and residual stress
3	Low	Medium	High	Possible at welds at intermediate combinations of ~ 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading, e.g., vibration.	
4	Low	Medium	High	Possible at welds at intermediate combinations of circa 2 ppm oxygen and 200F.	Needs dynamic loading conditions.
5	Low	Medium	High	Possible at welds at intermediate combinations of ~ 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading, e.g., vibration.	
6	Low	Medium	High	Possible at welds at intermediate combinations of ~ 2ppm oxygen and 200F. Liklihood will depend on source of applied dynamic loading, e.g., vibration.	Residual stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Possible at welds at intermediate combinations of ~ 2ppm oxygen and 200F. Likelihood will depend on source of applied dynamic loading, e.g., vibration.	

Subgroup **12.10**

Valves
SA216 - Carbon Steel
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
21,25,29,30,31,32,41,50,67,68

Notes: This water is demineralized, with, initially 6ppm O2 present. Operates at ~1100 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	
2	Low	High	High	Unlikely in condensate from properly controlled water chemistry	Geometrical crevices, deposits, water chemistry
3	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	
4	Low	High	High	Geometric crevices.	
5	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	
6	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	Geometry and corrosion products
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.10**

Valves
SA216 - Carbon Steel
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
21,25,29,30,31,32,41,50,67,68

Notes: This water is demineralized, with, initially 6ppm O2 present. Operates at ~1100 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
2	Low	High	High	Not an issue in condensate from properly controlled water chemistry	Water quality
3	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
4	Medium	High	High	Initially high, decreasing with time due to consumption of oxygen.	
5	Low	High	High	Initially high, decreasing with time due to decreasing oxygen content	
6	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	Potential and water chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.10**

Valves
SA216 - Carbon Steel
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
21,25,29,30,31,32,41,50,67,68

Notes: This water is demineralized, with, initially 6ppm O2 present. Operates at ~1100 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
2	Low	High	High	Assuming high quality condensate water and despite intermittent flushing	Water quality
3	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
4	Low	High	High	Unlikely due to good quality water and consumption of oxygen.	
5	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.10**

Valves
SA216 - Carbon Steel
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
21,25,29,30,31,32,41,50,67,68

Notes: This water is demineralized, with, initially 6ppm O2 present. Operates at ~1100 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
4	Low	Medium	Medium	Possible initially but will decrease with time due to consumption of oxygen.	
5	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	Potential and water chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.10**

Valves
SA216 - Carbon Steel
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
21,25,29,30,31,32,41,50,67,68

Notes: This water is demineralized, with, initially 6ppm O2 present. Operates at ~1100 psi and 120-170°F when active during flush every 3 months. No HWC benefit here. Always wetted from "keep-fill system"; water quality is good.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High oxygen condensate a potential concern for carbon steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Low	High	High	Oxygenated water part of the time.	
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	High	High	Carbon steels is susceptibl to SCC even wet steam as well as water.	Water impurities
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress, low temperature and relatively good purity water. Lowered confidence value mirrors the possible effect of dynamic strains in conjunction with intermediate O2 level circa 1-2 ppm	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.11**

Low alloy steel pump casing
A516 Gr 70
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
74,75

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC no benefit here. Always wetted from "keep-fill system"; water quality is good.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Pump only operates once briefly every 3 months	
2	Low	High	High	Low fatigue loading assumed since pump only operates briefly every 3 months	Cyclic loading
3	Low	High	High	Pump only operates once briefly every 3 months	
4	Low	High	High	Minimal loading problems - Stagnant water and pump only operates briefly every 3 months	
5	Low	High	High	Pump only operates once briefly every 3 months	
6	Low	High	High	Fatigue is not a issue because of limited operation time.	Stress amplitude and number of cycles. High cycle fatigue.
7	Low	High	High	Pump cycles may produce low cyclic harmonics as well as high frequency cyclic stressing.	
8	Low	High	High	Pump only operates once briefly every 3 months	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.11**

Low alloy steel pump casing
A516 Gr 70
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
74,75

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC no benefit here. Always wetted from "keep-fill system"; water quality is good.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
2	Low	High	High	Not an issue in condensate from properly controlled water chemistry	Water quality
3	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	
4	Medium	High	High	Initially high, decreasing with time due to consumption of oxygen.	
5	Low	High	High	Initially high, decreasing with time due to decreasing oxygen content	
6	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	Potential and water chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.11**

Low alloy steel pump casing
A516 Gr 70
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
74,75

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC no benefit here. Always wetted from "keep-fill system"; water quality is good.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
2	Low	High	High	Assuming high quality condensate water and despite intermittent flushing	Water quality
3	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
4	Low	High	High	Unlikely due to good quality water and consumption of oxygen.	
5	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable especially because this system is not flowing extensively.	
8	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	

Subgroup **12.11**

Low alloy steel pump casing
A516 Gr 70
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
74,75

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC no benefit here. Always wetted from "keep-fill system"; water quality is good.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
2	Low	High	High	Assuming high quality condensate water	Water quality
3	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
4	Low	Medium	Medium	Possible initially but will decrease with time due to consumption of oxygen.	
5	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	Potential and water chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.11**

Low alloy steel pump casing
A516 Gr 70
Stagnant condensate storage water, typically <100°F, 20-40 psia

Applies to BNL Part #s with prefix RCIC
74,75

Notes: This water is demineralized, with, initially, 6ppm O2 present. Operates at ~1140 psi and 120-170°F when active during flush every 3 months. HWC no benefit here. Always wetted from "keep-fill system"; water quality is good.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	High oxygen condensate a potential concern for low alloy steels where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
3	Low	High	High	a concern only if material severely cold-worked or highly stressed	
4	Low	High	High	Oxygenated water part of the time.	
5	Low	High	High	High oxygen condensate is a potential concern for carbon steels at locations where residual stresses are high.	Stress, sulfur content of steel and orientation and shape of sulfide inclusions.
6	Low	High	High	Low alloy steels is less susceptible but still susceptibl to SCC even wet steam as well as water.	Water impurities
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	Medium	High	Unlikely to be sustained due to lack of sufficient stress, low temperature and relatively good purity water. Lowered confidence value mirrors the possible effect of dynamic strains in conjunction with intermediate O2 level circa 1-2 ppm	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.12**

Various elbows, flanges, & pipe (base metal) in primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
54,59,62,64,66

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low susceptibility since a predominantly stagnant system	
2	Low	High	High	Fatigue loading assumed minor due to intermittent use	Cyclic loading
3	Low	High	High	Low susceptibility since a predominantly stagnant system	
4	Low	High	High	Low susceptibility since a predominantly stagnant system	
5	Low	High	High	Low susceptibility since a predominantly stagnant system	
6	Low	High	High	Low susceptibility since a predominantly stagnant system	Cause of cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	High	High	Low susceptibility since a predominantly stagnant system	

Subgroup **12.12**

Various elbows, flanges, & pipe (base metal) in primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
54,59,62,64,66

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	Potential and water chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	

Subgroup **12.12**

Various elbows, flanges, & pipe (base metal) in primary & secondary containment
SA105,106,216,234 - Carbon Steel
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54,59,62,64,66

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
4	Medium	High	High	Probable due to poor quality water and oxygen in suppresion pool water.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.12**

Various elbows, flanges, & pipe (base metal) in primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
54,59,62,64,66

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
6	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	Potential and water chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	

Subgroup **12.12**

Various elbows, flanges, & pipe (base metal) in primary & secondary containment
SA105,106,216,234 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
54,59,62,64,66

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely, in spite of poor water purity, due to low temperature and lack of obvious stress source	
2	Medium	High	Medium	Assuming poor water quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Unlikely, in spite of poor water purity, due to low temperature and lack of obvious stress source	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water.	
5	Low	High	High	Unlikely, in spite of poor water purity, due to low temperature and lack of obvious stress source	
6	Low	High	High	Unlikely, in spite of poor water purity, due to low temperature and lack of obvious stress source	Hardening
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Unlikely, in spite of poor water purity, due to low temperature and lack of obvious stress source	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.13**

Welds and HAZ in various elbows, flanges, & pipe in primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
55,56,58,63,65

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low susceptibility since a predominantly stagnant system	
2	Low	High	High	Fatigue loading assumed minor due to intermittent use	Cyclic loading
3	Low	High	High	Low susceptibility since a predominantly stagnant system	
4	Low	High	High	Low susceptibility since a predominantly stagnant system	
5	Low	High	High	Low susceptibility since a predominantly stagnant system	
6	Low	High	High	Low susceptibility since a predominantly stagnant system	Cause of cyclic stress
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	High	High	Low susceptibility since a predominantly stagnant system	

Subgroup **12.13**

Welds and HAZ in various elbows, flanges, & pipe in primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
55,56,58,63,65

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
6	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	Potential and water chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.13**

Welds and HAZ in various elbows, flanges, & pipe in primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
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Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
4	Medium	High	High	Probable due to poor quality water and oxygen in suppresion pool water.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.13**

Welds and HAZ in various elbows, flanges, & pipe in primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
55,56,58,63,65

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	Potential and water chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.13**

Welds and HAZ in various elbows, flanges, & pipe in primary & secondary containment
SA105,106,216,234 - Carbon Steel Weld metal
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
55,56,58,63,65

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration and impurity content in suppression pool	
2	Medium	High	Medium	Assuming poor water quality in suppression pool	Depends on water quality and residual stress
3	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration and impurity content in suppression pool	
4	Low	Medium	High	SCC unlikely at this low temperature, even though poor quality water.	
5	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration and impurity content in suppression pool	
6	Low	Medium	High	Possible at welds at intermediate combinations of circa 2ppm oxygen and 200F. Liklihood will depend on source of applied dynamic loading e.g vibration.	Residual stress at weld and cold work in elbows
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Here, the cold work will be increased and therefore the stresses..	
8	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration and impurity content in suppression pool	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.14**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
57

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Low fatigue loading since a predominantly stagnant system	
2	Low	High	High	Fatigue loading assumed minor due to intermittent use	Cyclic loading
3	Low	Medium	Medium	Low susceptibility since a predominantly stagnant system	
4	Low	High	Medium	Stagnant conditions most of the time	Generic problem with sockolets.
5	Low	Medium	Medium	Stagnant system so source of thermal eddies/dynamic strains lacking	
6	Low	Medium	Medium	Flow induced vibration is assumed minor	Can be small amplitude and very high cycles vinration
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverage for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Low	Medium	Medium	Low susceptibility since a predominantly stagnant system	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.14**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
57

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
6	Medium	High	High	Initially high, decreasing with time due to decreasing oxygen content	Potential and water chemistry
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.14**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
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57

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
4	Medium	High	High	Probable due to poor quality water and oxygen in suppresion pool water.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.14**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
57

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
6	Low	Medium	Medium	Possible initially but likelihood will decrease with time due to removal of oxygen due to corrosion	Potential and water chemistry
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.14**

Weldolets and Sockolets
SA105,106,234 - Carbon Steel Base & Weld
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
57

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration, and impurity content in suppression pool	
2	Medium	High	Medium	Assuming poor water quality in suppression pool	Depends on water quality and residual stress
3	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration, and impurity content in suppression pool	
4	Low	Medium	High	SCC unlikely at this low temperature, even though poor quality water.	
5	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration, and impurity content in suppression pool	
6	Low	Medium	High	Possible at welds at intermediate combinations of ~ 2ppm oxygen and 200F. Liklihood will depend on source of applied dynamic loading, e.g., vibration.	Residual stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading, e.g., vibration and impurity content in suppression pool	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.15**

Valves
SA216 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
60,61

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	High	Depends entirely on crevice geometry. These valves are close enough to the suppression pool that oxygen will still be in water.	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	Medium	High	Depends entirely on crevice geometry. These valves are close enough to the suppression pool that oxygen will still be in water.	
4	Medium	Medium	High	Geometric crevices present.	
5	Medium	Medium	High	Depends entirely on crevice geometry. These valves are close enough to the suppression pool that oxygen will still be in water.	
6	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	Geometry and corrosion products
7	High	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	Medium	High	Depends entirely on crevice geometry. These valves are close enough to the suppression pool that oxygen will still be in water.	

Subgroup **12.15**

Valves
SA216 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
60,61

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Low susceptibility since a predominantly stagnant system	
2	Low	High	High	Fatigue loading assumed minor due to infrequent use	Cyclic loading
3	Low	High	High	Low susceptibility since a predominantly stagnant system	
4	Low	High	High	Low susceptibility since a predominantly stagnant system	
5	Low	High	High	Low susceptibility since a predominantly stagnant system	
6	Low	High	High	Low susceptibility since a predominantly stagnant system	
7	Low	High	High	The valves do not appear especially prone to large cyclic loading.	
8	Low	High	High	Low susceptibility since a predominantly stagnant system	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.15**

Valves
SA216 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
60,61

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
2	Low	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.15**

Valves
SA216 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
60,61

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
4	Medium	High	High	Probable due to poor quality water and oxygen in suppresion pool water.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Medium	Medium	Medium	The occurrence of MIC is highly probable	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.15**

Valves
SA216 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
60,61

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
2	Medium	High	High	Assuming poor quality in suppression pool	Depends on water quality
3	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
6	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	

Subgroup **12.15**

Valves
SA216 - Carbon Steel
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
60,61

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading e.g. vibration, and impurity content in suppression pool	
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading e.g. vibration, and impurity content in suppression pool	
4	Low	Medium	High	SCC unlikely at this low temperature, even though poor quality water.	
5	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading e.g. vibration, and impurity content in suppression pool	
6	Low	Medium	High	Possible at welds but susceptibility is ranked low because ofl ow temperature. Rating will increase depending on source of applied dynamic loading e.g vibration.and impurity content in suppression pool	
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Possible at welds but susceptibility is ranked low because of low temperature. Rating will increase depending on source of applied dynamic loading e.g. vibration, and impurity content in suppression pool	

Subgroup **12.16**

RCIC Strainer Flange & misc. components
304 SS
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
77,78,79,80

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	High	Depends entirely on crevice geometry. These components are immersed in the partially aerated, poor quality water.	
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	Medium	High	Depends entirely on crevice geometry. These components are immersed in the partially aerated, poor quality water.	
4	Medium	Medium	High	Geometric crevices present.	
5	Medium	Medium	High	Depends entirely on crevice geometry. These components are immersed in the partially aerated, poor quality water.	
6	Medium	Medium	High	Depends entirely on crevice geometry. These components are immersed in the partially aerated, poor quality water.	
7	Low	Medium	Medium	Crevice corrosion less likely than for CS. Depends on water chemistry and oxygen.	
8	Medium	Medium	High	Depends entirely on crevice geometry. These components are immersed in the partially aerated, poor quality water.	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.16**

RCIC Strainer Flange & misc. components
304 SS
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
77,78,79,80

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unlikely since no obvious source of vibrator load during majority of time	
2	Low	High	High	Fatigue loading assumed minor since ECCS is rarely used	Cyclic loading
3	Low	High	High	Unlikely since no obvious source of vibrator load during majority of time	
4	Low	High	High	Unlikely since no obvious source of vibrational load for most of the time.	
5	Low	High	High	Unlikely since no obvious source of vibrator load during majority of time	
6	Low	High	High	Unlikely since no obvious source of vibrator load durin majority of time	
7	Low	High	High	Fatigue of SS not so intense for stainless steel partly because of lack of so much pitting.	
8	Low	High	High	Unlikely since no obvious source of vibrator load during majority of time	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.16**

RCIC Strainer Flange & misc. components
304 SS
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
77,78,79,80

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Stainless steel probably OK in spite of poor quality water	
2	Low	High	High	GC of stainless steel insignificant despite poor quality water	
3	Low	High	High	Stainless steel probably OK in spite of poor quality water	
4	Low	High	High	Stainless steel probably OK in spite of poor quality water	
5	Low	High	High	Stainless steel probably OK in spite of poor quality water	
6	Low	High	High	Stainless steel probably OK in spite of poor quality water	
7	Low	High	High	Low GC at these temperatures	
8	Low	High	High	Stainless steel probably OK in spite of poor quality water	

Group **12** **Auxiliary System** **Reactor Core Isolation Cooling**

Subgroup **12.16**

RCIC Strainer Flange & misc. components
304 SS
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
77,78,79,80

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
2	Medium	High	High	Assuming poor quality in suppression pool. Flushing ~3 months aggravates MIC.	Depends on water quality
3	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
4	Medium	High	High	Probable due to poor quality water and oxygen in suppresion pool water.	
5	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water	Would be a susceptibility score of 3 if there was plant observayions (have any been made?)
7	Medium	Medium	Medium	MIC is probable even in SS but the conditions are not certain.	
8	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water	Would be a susceptibility score of 3 if there was plant observations (have any been made?)

Subgroup **12.16**

RCIC Strainer Flange & misc. components
304 SS
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
77,78,79,80

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Depends entirely on the specific composition of the suppression pool water	
2	Medium	High	High	Assuming poor water quality in suppression pool water	Depends on water quality
3	Medium	Medium	Medium	Depends entirely on the specific composition of the suppression pool water	
4	Medium	Medium	Medium	Depends entirely on the specific composition of the suppression pool water	
5	Medium	Medium	Medium	Depends entirely on the specific composition of the suppression pool water	
6	Medium	Medium	Medium	Depends entirely on the specific composition of the suppression pool water	
7	Medium	Medium	Medium	In these environments, pitting of SS can occur.	
8	Medium	Medium	Medium	Depends entirely on the specific composition of the suppression pool water	

Subgroup **12.16**

RCIC Strainer Flange & misc. components
304 SS
Suppression pool water for cooling, typically <100°F and atmospheric pressure

Applies to BNL Part #s with prefix RCIC
77,78,79,80

Notes: Once-demineralized but no water treatment. Inefficiently N2 blanked (only in Mark 1and Mark 2, which are most plants); assume O2 present. Operates at ~20 psia when active during flush every 3 months. Always wetted from "keep-fill system"; water quality can be poor.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Possible but depends entirely on the specific composition of the suppression pool water	The assumption is that the welds in this component are not stress relieved
2	Low	High	Medium	Assuming poor quality in suppression pool	Depends on water quality and residual stress
3	Low	High	High	Possible but depends entirely on the specific composition of the suppression pool water	The assumption is that the welds in this component are not stress relieved
4	Low	High	High	SCC unlikely at this low temperature.	The assumption is that the welds in this component are not stress relieved
5	Low	High	High	Possible but depends entirely on the specific composition of the suppression pool water	The assumption is that the welds in this component are not stress relieved
6	Low	High	High	Possible but depends entirely on the specific composition of the suppression pool water	The assumption is that the welds in this component are not stress relieved
7	Low	High	High	At these temperatures, SCC of SS less intense but can occur if there are means for concentration	
8	Medium	High	High	Possible but depends entirely on the specific composition of the suppression pool water and especially in 2ppm O2 region	The assumption is that the welds in this component are not stress relieved

Group
13

Engineered Safety Feature System

RHR Suction Line Piping to RHR Pumps

Subgroup
13.1

All Stainless Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPS
All

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Not an obvious situation in which MIC is expected to flourish.	External surface wetness, nutrients, temperature
3	Low	High	High	a possible concern if surfaces contaminated with deposits, etc.; surfaces must be wet	
4	Low	High	High	Should not be a problem with good practice.	
5	Low	High	High	MIC might be possible here but isn't likely to be a significant problem	External surface wetness, nutrients, temperature
6	Low	High	High	Less susceptible to MIC	
7	Low	Medium	Medium	MIC occurs only when wet and nutrients are present.	
8	Low	Medium	High	Possible if wetted with aerated water (with CO2 nutrient), but unlikely due to intermediate higher temperature	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.1**

All Stainless Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPS
All

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	a concern only if surfaces can accumulate deposits and are wetted	
4	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.
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Requires moisture and chloride, so is most likely during outages and layup
6	Medium	High	High	Surafce contamination and insulator may assist pit initiation	Cl contamination at the surface and insulator
7	Low	High	High	SCC occurs only when wetted and contaminants are present	
8	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

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.1**

All Stainless Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPS
All

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	possible for highly stressed areas where surfaces alternately wet/dry	
4	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.
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Requires moisture and chloride, so is most likely during outages and layup
6	Medium	High	High	Surafce contamination and insulator may assist SCC initiation	Cl contamination at the surface and insulator
7	Low	High	High	SCC occurs only when wetted and contaminants are present	
8	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)

Group
13

Engineered Safety Feature System

RHR Suction Line Piping to RHR Pumps

Subgroup
13.2

Straight pipes, Elbows, Tee, Valves
304 SS - Weld and Base Metal
Reactor Water normally stagnant
549°F, pressure 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
2,4
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	needs thermal mixing	some plant experience
4	Low	High	High	Good field experience, but thermal fatigue possible at Tees and upstream of valves	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	Medium	Medium	Init by SCC, pits, high residual stresses, experience is good	
8	Medium	Medium	High	Fatigue usage probably low due to stagnant line. However some indications in France and Sweden	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.2**

Straight pipes, Elbows, Tee, Valves
304 SS - Weld and Base Metal
Reactor Water normally stagnant
549°F, pressure 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
2,4
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High	needs thermal mixing	
4	Low	High	High	Good field experience, but thermal fatigue possible at Tees and upstream of valves	Water is stagnant so HWC cannot be maintained.
5	Low	Medium	High	No significant effect of HWC expected here	
6	Low	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Less serious than NWC	
8	Low	Medium	High		

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.2**

Straight pipes, Elbows, Tee, Valves
304 SS - Weld and Base Metal
Reactor Water normally stagnant
549°F, pressure 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
2,4
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High	a concern only for heavily cold-worked areas	
4	Low	Medium	Medium	Insufficient data, but lab indications could be a problem in welds.	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Not a issue under normal condition	
7	Low	High	High	Inherently tough material	
8	Medium	Medium	Medium	Lack of data in Water and evaluation of weld constraint	

Group
13

Engineered Safety Feature System

RHR Suction Line Piping to RHR Pumps

Subgroup
13.2

Straight pipes, Elbows, Tee, Valves
304 SS - Weld and Base Metal
Reactor Water normally stagnant
549°F, pressure 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
2,4
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	needs high stresses plus oxidizing environment	
4	Medium	High	High	C content, cold work and historically poor chemistry aggravating factors.	
5	Low	High	High	Base metal and weld metal are not very susceptible	
6	Low	High	High	Less susceptible than 304 SS HAZ	
7	Medium	High	High	Oxygen, residual stresses produce SCC	
8	Medium	Medium	High	Uncertain source of stress. Probably susceptibility score should be 1	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.2**

Straight pipes, Elbows, Tee, Valves
304 SS - Weld and Base Metal
Reactor Water normally stagnant
549°F, pressure 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
2,4
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely in HWC	
4	Medium	High	High	Water is stagnant so HWC cannot be maintained.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	No significant effect of HWC expected here	
6	Low	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	High	High	HWC reduces SCC	
8	Low	High	High		

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.3**

Weld HAZ
304 SS HAZ
Reactor Water normally stagnant
549°F, 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
1,3
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	needs thermal mixing	some plant experience
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is minor	
7	Low	Medium	Medium	Init by SCC, pits, high residual stresses, experience is good	
8	Low	Medium	High	Fatigue usage probably low due to stagnant line	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.3**

Weld HAZ
304 SS HAZ
Reactor Water normally stagnant
549°F, 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
1,3
Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High	needs thermal mixing	
4	Low	High	High	Good experience. Possible environmental effect.	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Role of hydrogen in fatigue is not clear in conjunction with dynamic strain aging
7	Low	Medium	Medium	Less serious than NWC	
8	Low	Medium	High		

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.3**

Weld HAZ
304 SS HAZ
Reactor Water normally stagnant
549°F, 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
1,3
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High	a concern only for heavily cold-worked areas	
4	Medium	Medium	Medium	Insufficient data, but lab indications could be a problem.	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Not a issue under normal condition	
7	Low	High	High	Inherently tough material but weld toughness lower	
8	Medium	Medium	Medium	Lack of data in water and evaluation of weld constraint	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.3**

Weld HAZ
304 SS HAZ
Reactor Water normally stagnant
549°F, 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
1,3
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High	potential for sensitized materials	
4	Medium	High	High	Generic problem. Dynamic loading conditions probably not present under stagnant conditions.	C content, cold work and historically poor chemistry aggravating factors.
5	Medium	High	High	HAZs are susceptible to SCC	
6	Medium	High	High	Susceptible under these condition.	Weld strain hardening is important
7	Medium	High	High	Oxygen, residual stresses produce SCC	
8	Medium	Medium	High		

Group
13

Engineered Safety Feature System

RHR Suction Line Piping to RHR Pumps

Subgroup
13.3

Weld HAZ
304 SS HAZ
Reactor Water normally stagnant
549°F, 1035 psia

Applies to BNL Part #s with prefix RHRPMPS
1,3
Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High	unlikely in HWC	
4	Medium	High	High	Generic problem. Dynamic loading conditions probably not present under stagnant conditions. Difficult to maintain HWC under stagnant conditions.	C content, cold work and historically poor chemistry aggravating factors.
5	Low	High	High	HWC benefit expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Cracking provides a stress concentration where hydrogen tend to diffuse in. Role of hydrogen in metals is critical.
7	Low	High	High	HWC reduces SCC	
8	Low	High	High		

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.4**

Straight pipes, Elbows, Tee, Valves
304 SS
Reactor Water normally stagnant
100-350°F, 300 psia. No HWC effect

Applies to BNL Part #s with prefix RHRPMPS
5,6,7,9,11,14,15,17,18,20,21,23,26,24,27,29,30,33,36,37,39,41
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	potential if thermal mixing possible	
4	Low	High	High	Good field experience, but thermal fatigue possible at Tees and upstream of valves	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	High	High	Fatigue less at lower temperatures. Not often observed in practice	
8	Low	Medium	High	Fatigue usage probably low due to stagnant line	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.4**

Straight pipes, Elbows, Tee, Valves
304 SS
Reactor Water normally stagnant
100-350°F, 300 psia. No HWC effect

Applies to BNL Part #s with prefix RHRPMPS
5,6,7,9,11,14,15,17,18,20,21,23,26,24,27,29,30,33,36,37,39,41
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Low risk of SCC even in oxidizing conditions due to low temperature	Stress, metallurgical condition, cold work, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High	Probably not a problem at the lower temperatures.	
5	Low	High	High	Base metal and weld metal are not very susceptible	
6	Low	High	High	Less susceptible than 304 SS HAZ	Cold work may increase SCC susceptibility even at these temperature.
7	Low	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. Not often observed in practice.	
8	Low	High	High	Unlikely given low temp and unclear source of stress	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.5**

Welds SS 308
Reactor Water normally stagnant
100-350°F, 300 psia. No HWC effect

Applies to BNL Part #s with prefix RHRPMPS
8,10,12,13,16,22,25,27,28,30,32,34,35,38,39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading, weld defects
3	Medium	High	High	concern for thermal mixing	
4	Low	High	High	Good field experience.	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Unlikely without any fatigue loading source	
7	Low	High	High	Fatigue less at lower temperatures. Not often observed in practice. 308 less than 304. Not often observed in practice in these temperature ranges.	
8	Low	Medium	High	Fatigue usage probably low due to stagnant line	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.5**

Welds SS 308
Reactor Water normally stagnant
100-350°F, 300 psia. No HWC effect

Applies to BNL Part #s with prefix RHRPMPS
8,10,12,13,16,22,25,27,28,30,32,34,35,38,39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Low risk of SCC even in oxidizing conditions due to duplex microstructure and low temperature	Water quality, oxidation potential
3	Low	High	High	potential for highly stressed areas	
4	Low	High	High	Good field experience.	
5	Low	High	High	Base metal and weld metal are not very susceptible	
6	Low	High	High	Unlikely for weld 308 at these temperature	
7	Low	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. Not often observed in practice. 308 less intense than 304	
8	Low	High	High	Unlikely given low temp and lack of sustainable O2 in stagnant line	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.6**

Socket welds
Reactor Water normally stagnant
100-350°F, 300 psia. No HWC effect

Applies to BNL Part #s with prefix RHRPMPS
12.19

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Limited fatigue loading in stagnant system	
2	Medium	High	Medium	Flow induced vibration in deadlegs when operating	Cyclic loading, socket weld design, fabrication defects
3	Medium	High	High	thermal mixing possible	
4	Medium	High	High	Generic problems with socket welds.	
5	Low	Medium	Medium	Normally stagnant so excessive vibration isn't very likely	
6	Medium	Medium	Medium	One of the concerned degradation	Crevice and geometry of socket and weld
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Fatigue usage probably low due to stagnant line	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.6**

Socket welds
Reactor Water normally stagnant
100-350°F, 300 psia. No HWC effect

Applies to BNL Part #s with prefix RHRPMPS
12.19

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC even in oxidizing reactor water due to low temperature	Stress, metallurgical condition, cold work, water quality, oxidation potential
3	Medium	High	High	high stresses; possible oxidizing conditions	
4	Low	High	High	Probably not a problem at the lower temperatures.	
5	Low	High	High	SCC is not very likely for stainless steels under these conditions except perhaps in the HAZ	
6	Medium	Medium	Medium	Synergy effects with fatigue is not clear.	Crevice and geometry of socket and weld
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Low	High	High	Unlikely given low temp and lack of sustainable O2 in stagnant line	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.7**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPS
All

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Not an obvious situation in which MIC is expected to flourish.	External surface wetness, nutrients, temperature
3	Low	High	High	a possible concern if surfaces contaminated with deposits, etc.; surfaces must be wet	
4	Low	High	High	Should not be a problem with good practice.	
5	Low	High	High	MIC might be possible here but isn't likely to be a significant problem	External surface wetness, nutrients, temperature
6	Low	High	High	Posible degradation mechanism in this condition depending upon water quality	
7	Low	Medium	Medium	Probably surfaces are clean. However, especially fungal MIC can encure long periods of dryness and then produce acidic sites depending on nutrients. Dissolved CO2 is good nutrient.	
8	Low	Medium	High	Possible if wetted with aerated water (with CO2 nutrient), but unlikely due to intermediate higher temperature	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.7**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPS
All

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unless surface stays wet a large fraction of the time, pitting should be limited and shallow	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites. Unlikely to affect integrity	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	not likely unless surfaces wetted at least some of the time	
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	Low	High	High	Potential degradation when wetted.	
7	Low	Medium	Medium	Pitting can be expected if the surfaces are wet and contaminated. Such events are probably infrequent.	
8	Low	Medium	High	Assumes that surface really stays dry. If not then score increases to at least 2	

Group
13

Engineered Safety Feature System

RHR Suction Line Piping to RHR Pumps

Subgroup
13.8

Carbon Steel Welds & HAZ
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm NWC water during operation

Applies to BNL Part #s with prefix RHRPMPS
43,46,48,49,50,52,53,55,57

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	possible in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	Geometry and corrosion products
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.8**

Carbon Steel Welds & HAZ
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm NWC water during operation

Applies to BNL Part #s with prefix RHRPMPS
43,46,48,49,50,52,53,55,57

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor due to intermittent use	Cyclic loading
3	Low	High	High	unlikely since system not operated frequently	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Low susceptibility since a predominantly stagnant system	
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.8**

Carbon Steel Welds & HAZ
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm NWC water during operation

Applies to BNL Part #s with prefix RHRPMPS
43,46,48,49,50,52,53,55,57

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	should not be a major issue	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.8**

Carbon Steel Welds & HAZ
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm NWC water during operation

Applies to BNL Part #s with prefix RHRPMPS
43,46,48,49,50,52,53,55,57

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	seems possible given stagnant/near stagnant exposures to suppression pool water	
4	Medium	High	High	Probable due to poor quality water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.8**

Carbon Steel Welds & HAZ
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm NWC water during operation

Applies to BNL Part #s with prefix RHRPMPS
43,46,48,49,50,52,53,55,57

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	seems probable given stagnant/near stagnant exposures to suppression pool water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.8**

Carbon Steel Welds & HAZ
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm NWC water during operation

Applies to BNL Part #s with prefix RHRPMPS
43,46,48,49,50,52,53,55,57

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	possible depending on stresses	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	Medium	High	Possible at welds but susceptibility is ranked low because ofl ow temperature. Rating will increase depending on source of applied dynamic loading e.g vibration.and impurity content in suppression pool	Weld strain may increase an hardness
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Welds produce high local stresses.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.9**

CS Straight pipes, Elbows, Tee, Valves
SA234 Gr. WPB
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm

Applies to BNL Part #s with prefix RHRPMPS
42,44,45,47,51,54,56,58

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Medium	High	High	possible in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Low	High	High	Possible, but dependent on extent of oxygen in water and its removal rate due to corrosion	Geometry and corrosion products
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.9**

CS Straight pipes, Elbows, Tee, Valves
SA234 Gr. WPB
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm

Applies to BNL Part #s with prefix RHRPMPS
42,44,45,47,51,54,56,58

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor to be within code allowable	Cyclic loading
3	Low	High	High	cyclic stresses do not seem sufficient	
4	Low	High	High		
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Low susceptibility since a predominantly stagnant system	
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.9**

CS Straight pipes, Elbows, Tee, Valves
SA234 Gr. WPB
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm

Applies to BNL Part #s with prefix RHRPMPS
42,44,45,47,51,54,56,58

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	should not be a major issue	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of carbon steel)	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.9**

CS Straight pipes, Elbows, Tee, Valves
SA234 Gr. WPB
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm

Applies to BNL Part #s with prefix RHRPMPS
42,44,45,47,51,54,56,58

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Low	High	High	seems possible given stagnant/near stagnant exposures to suppression pool water	
4	Medium	High	High	Probable due to poor quality water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely due to good purity water plus removal of oxygen with time due to corrosion of carbon steel	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.9**

CS Straight pipes, Elbows, Tee, Valves
SA234 Gr. WPB
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm

Applies to BNL Part #s with prefix RHRPMPS
42,44,45,47,51,54,56,58

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	seems probable given stagnant/near stagnant exposures to suppression pool water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppresion pool water. Will probably decrease at locations further from pool due to drop in oxygen content (associated with corrosion of c steel)	
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **13** **Engineered Safety Feature System** **RHR Suction Line Piping to RHR Pumps**

Subgroup **13.9**

CS Straight pipes, Elbows, Tee, Valves
SA234 Gr. WPB
Suppression pool water
120-170°F, 20 psia flow rate 7450 gpm

Applies to BNL Part #s with prefix RHRPMPS
42,44,45,47,51,54,56,58

Notes: Replaced with condensate water before going into shutdown cooling mode. No HWC effect.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	Medium	High	Possible at welds but susceptibility is ranked low because ofl ow temperature. Rating will increase depending on source of applied dynamic loading e.g vibration.and impurity content in suppression pool	Elbows may be work hardened during a process.
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Cold worked components in BWRs are stress relieved although magnitude of benefit not clear.	
8	Low	Medium	High	Unlikely at these temps in good purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.1**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPHX
All

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Not an obvious situation in which MIC is expected to flourish.	External surface wetness, nutrients, temperature
3	Low	High	High	a possible concern if surfaces contaminated with deposits, etc.; surfaces must be wet	
4	Low	High	High	Should not be a problem with good practice.	
5	Low	High	High	MIC might be possible here but isn't likely to be a significant problem	External surface wetness, nutrients, temperature
6	Low	High	High	Posible degradation mechanism in this condition depending upon water quality	
7	Low	Medium	Medium	Probably surfaces are clean. However, especially fungal MIC can encure long periods of dryness and then produce acidic sites depending on nutrients. Dissolved CO2 is good nutrient.	
8	Low	Medium	High	Possible if wetted with aerated water (with CO2 nutrient), but unlikely due to intermediate higher temperature	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.1**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRPMPHX
All

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unless surface stays wet a large fraction of the time, pitting should be limited and shallow	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites. Unlikely to affect integrity	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	needs wetted surface at least part of the time	
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	Low	High	High	Potentialproblem only when wetted.	Cl concentration
7	Low	Medium	Medium	Pitting can be expected if the surfaces are wet and contaminated. Such events are probably infrequent.	
8	Low	Medium	High	Assumes that surface really stays dry. If not then score increases to at least 2	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
1,3,5,9,12,13,15,17,18,20,22,24,26,30,32,34,39,40,42,45,48,50,52,54,56,58,61,62,64

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
1,3,5,9,12,13,15,17,18,20,22,24,26,30,32,34,39,40,42,45,48,50,52,54,56,58,61,62,64

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
1,3,5,9,12,13,15,17,18,20,22,24,26,30,32,34,39,40,42,45,48,50,52,54,56,58,61,62,64

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
1,3,5,9,12,13,15,17,18,20,22,24,26,30,32,34,39,40,42,45,48,50,52,54,56,58,61,62,64

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC. Also minimum at the higher end of temperatures >200F.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
1,3,5,9,12,13,15,17,18,20,22,24,26,30,32,34,39,40,42,45,48,50,52,54,56,58,61,62,64

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
1,3,5,9,12,13,15,17,18,20,22,24,26,30,32,34,39,40,42,45,48,50,52,54,56,58,61,62,64

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Cold worked components in BWRs are stress relieved although magnitude of benefit not clear.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.3**

Carbon Steel Weld and HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
2,4,6,8,10,11,14,16,19,21,23,25,27,29,31,33,35,37,38,41,43,55,47,49,51,53,55,57,59,60,63,65,66,72,73,74

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.3**

Carbon Steel Weld and HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
2,4,6,8,10,11,14,16,19,21,23,25,27,29,31,33,35,37,38,41,43,55,47,49,51,53,55,57,59,60,63,65,66, 72,73,74

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.3**

Carbon Steel Weld and HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
2,4,6,8,10,11,14,16,19,21,23,25,27,29,31,33,35,37,38,41,43,55,47,49,51,53,55,57,59,60,63,65,66,72,73,74

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.3**

Carbon Steel Weld and HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
2,4,6,8,10,11,14,16,19,21,23,25,27,29,31,33,35,37,38,41,43,55,47,49,51,53,55,57,59,60,63,65,66,72,73,74

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.3**

Carbon Steel Weld and HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
2,4,6,8,10,11,14,16,19,21,23,25,27,29,31,33,35,37,38,41,43,55,47,49,51,53,55,57,59,60,63,65,66,72,73,74

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.3**

Carbon Steel Weld and HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
2,4,6,8,10,11,14,16,19,21,23,25,27,29,31,33,35,37,38,41,43,55,47,49,51,53,55,57,59,60,63,65,66,72,73,74

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Welds produce high local stresses.	
8	Low	Medium	High	Unlikely at these temps in good purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.4**

Weldolet/Sockolet
SA234 Gr. WPB
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
7,28,36,67
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.4**

Weldolet/Sockolet
SA234 Gr. WPB
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
7,28,36,67

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Limited fatigue in stagnant areas	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Medium	High	High	needs high cyclic stresses; seems likely here	
4	Low	High	High	Stagnant water most of the time.	Generic problems with sockolets.
5	Low	Medium	Medium	Normally stagnant so excessive vibration isn't very likely	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.4**

Weldolet/Sockolet
SA234 Gr. WPB
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
7,28,36,67

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.4**

Weldolet/Sockolet
SA234 Gr. WPB
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
7,28,36,67

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.4**

Weldolet/Sockolet
SA234 Gr. WPB
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
7,28,36,67

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.4**

Weldolet/Sockolet
SA234 Gr. WPB
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
7,28,36,67

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.5**

HX Weld in SS, or CS with 1/8" Clad/overlay
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
68,69,70,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.5**

HX Weld in SS, or CS with 1/8" Clad/overlay
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
68,69,70,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Component with failures reported although cause not investigated.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of sustained cyclic load	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.5**

HX Weld in SS, or CS with 1/8" Clad/overlay
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
68,69,70,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Negligible even assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Low	High	High	SS overlay should be more resistant than CS	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.5**

HX Weld in SS, or CS with 1/8" Clad/overlay
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
68,69,70,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool and despite occasional flushing with good quality water.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.5**

HX Weld in SS, or CS with 1/8" Clad/overlay
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
68,69,70,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Low	High	High	SS overlay should be more resistant than CS	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.5**

HX Weld in SS, or CS with 1/8" Clad/overlay
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
68,69,70,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Low risk even assuming poor quality from suppression pool due to low temperature	Depends on water quality, temperature and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	Component with failures reported but cause not investigated although SCC unlikely at the low temperature.	
5	Low	High	High	SCC is not very likely for stainless steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Low	Medium	High	Unlikely at these temps in good purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.6**

Heat exchanger tubes and tubesheet - outside tubes
CS w/outside clad of SS
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Component with failures reported although cause not investigated.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	Possible fatigue owing to vibration from cross flow.	
8	Low	Medium	High	Unclear source of sustained cyclic load	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.6**

Heat exchanger tubes and tubesheet - outside tubes
CS w/outside clad of SS
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool and despite occasional flushing with good quality water.	Depends on water quality
3	Low	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	MIC unlikely on outside owing to high velocities of outside flow. Also, temperature range at hot range is too high.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.6**

Heat exchanger tubes and tubesheet - outside tubes
CS w/outside clad of SS
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Low	High	High	SS overlay should be more resistant than CS	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Low	Medium	Medium	Pitting is possible with flow and oxygen. Not aware of bad field experience.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.6**

Heat exchanger tubes and tubesheet - outside tubes
CS w/outside clad of SS
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Low risk even assuming poor quality from suppression pool due to low temperature	Depends on water quality, temperature and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	Component with failures reported but cause not investigated although SCC unlikely at the low temperature.	
5	Low	High	High	SCC is not very likely for stainless steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Low	Medium	Medium	Possible SCC owing to residual stresses and vibration from cross flow.	
8	Low	Medium	High	Unlikely at these temps in good purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.7**

Heat exchanger tubes and tubesheet - inside tubes
Carbon Steel
Service water (treated) - 100°F

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Low	High	High	crevices unlikely to be present unless deposits build up	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Depends on service water treatment and flow rate -- assume good treatment and low flowrate	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Subgroup **14.7**

Heat exchanger tubes and tubesheet - inside tubes
Carbon Steel
Service water (treated) - 100°F

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Component with failures reported although cause not investigated.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	Depends on cross flow	
8	Low	Medium	High	Unclear source of sustained cyclic load	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.7**

Heat exchanger tubes and tubesheet - inside tubes
Carbon Steel
Service water (treated) - 100°F

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming properly treated water	Depends on water quality
3	Low	High	High	high initially but decreases with time	
4	Low	High	Medium	Presence of oxygen and relatively low temperature.	
5	Low	Medium	High	Depends on service water treatment and flow rate -- assume good treatment and low flowrate	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	Medium	Possible at this low temperature if no oxygen suppression	

Subgroup **14.7**

Heat exchanger tubes and tubesheet - inside tubes
Carbon Steel
Service water (treated) - 100°F

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming properly treated water	Depends on water quality
3	Low	High	High	probable given stagnant low temperature water	
4	Low	High	Medium	Presence of oxygen and relatively low temperature.	
5	Low	Medium	High	Depends on service water treatment and flow rate -- assume good treatment and low flowrate	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	Flow too high for MIC but animal accumulation, fouling, may be important	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **14.7**

Heat exchanger tubes and tubesheet - inside tubes
Carbon Steel
Service water (treated) - 100°F

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming properly treated water	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Low	High	Medium	Presence of oxygen and relatively low temperature.	
5	Low	Medium	High	Depends on service water treatment and flow rate -- assume good treatment and low flowrate	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Low	Medium	Medium		

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.7**

Heat exchanger tubes and tubesheet - inside tubes
Carbon Steel
Service water (treated) - 100°F

Applies to BNL Part #s with prefix RHRPMPHX
75,76

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Assuming properly treated water	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	Component with failures reported but cause not investigated although SCC unlikely at the low temperature.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Unlikely at these temps in good purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.8**

HX Fittings
Carbon Steel
Suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
77
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Low	High	High	crevices unlikely to be present unless deposits build up	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes and components, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.8**

HX Fittings
Carbon Steel
Suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
77
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Component with failures reported although cause not investigated.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	Depends on flow stresses	
8	Low	Medium	High	Unclear source of cyclic load	

Group **14** **Engineered Safety Feature System**

RHR Pump Discharge Piping to RHR HX

Subgroup **14.8**

HX Fittings
Carbon Steel
Suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
77

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreases with time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Poor water quality and oxygen will lead to general corrosion	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.8**

HX Fittings
Carbon Steel
Suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
77
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Low	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	Flow too high for MIC but animal accumulation, fouling, may be important	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.8**

HX Fittings
Carbon Steel
Suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
77
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	High	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.8**

HX Fittings
Carbon Steel
Suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRPMPHX
77
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	Component with failures reported but cause not investigated although SCC unlikely at the low temperature.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in this range of temperature. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Unlikely at these temps in good purity water	

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.9**

External heat exchanger support structure
Carbon steel
Secondary containment atmosphere

Applies to BNL Part #s with prefix RHRPMPHX
78

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Not aware of consequential fatigue loading	
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	seems unlikely given intermittent operation	
4	Medium	High	High	Known problem, replacement components often redesigned.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	Depends on wetness, atmospheric contaminants, geometry and stress cycling. These do not seem well known. Not aware of field experience.	
8	Medium	Medium	High		

Group **14** **Engineered Safety Feature System** **RHR Pump Discharge Piping to RHR HX**

Subgroup **14.9**

External heat exchanger support structure
Carbon steel
Secondary containment atmosphere

Applies to BNL Part #s with prefix RHRPMPHX
78

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unless surface stays wet a large fraction of the time, pitting should be limited and shallow	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites. Unlikely to affect integrity	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	environment should be dry; pitting needs moist/wet environment	
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Low	Medium	Medium	Adequate oxygen available but wetness is probably limited. Availability of chemicals is probably limited.	
8	Low	Medium	High	Unlikely if kept dry	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.1**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRSHTDWN
All

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Not an obvious situation in which MIC is expected to flourish.	External surface wetness, nutrients, temperature
3	Low	High	High	a possible concern if surfaces contaminated with deposits, etc.; surfaces must be wet	
4	Low	High	High	Should not be a problem with good practice.	
5	Low	High	High	MIC might be possible here but isn't likely to be a significant problem	External surface wetness, nutrients, temperature
6	Low	High	High	Posible degradation mechanism in this condition depending upon water quality	
7	Low	Medium	Medium	Probably surfaces are clean. However, especially fungal MIC can encure long periods of dryness and then produce acidic sites depending on nutrients. Dissolved CO2 is good nutrient.	
8	Low	Medium	High	Possible if wetted with aerated water (with CO2 nutrient), but unlikely due to intermediate higher temperature	

Subgroup **15.1**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRSHTDWN
All

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unless surface stays wet a large fraction of the time, pitting should be limited and shallow	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites. Unlikely to affect integrity	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	needs moist environment/wetted surface at least some of the time	
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	Low	High	High	Potentialproblem only when wetted.	Cl concentration
7	Low	Medium	Medium	Pitting can be expected if the surfaces are wet and contaminated. Such events are probably infrequent.	
8	Low	Medium	High	Assumes that surface really stays dry. If not then score increases to at least 2	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
1,4,11,13,14,15,21,23,24,26,30,32,34,35,37,41,43,47,49,51,55,60,61,63,65
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
1,4,11,13,14,15,21,23,24,26,30,32,34,35,37,41,43,47,49,51,55,60,61,63,65
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
1,4,11,13,14,15,21,23,24,26,30,32,34,35,37,41,43,47,49,51,55,60,61,63,65
Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
1,4,11,13,14,15,21,23,24,26,30,32,34,35,37,41,43,47,49,51,55,60,61,63,65
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
1,4,11,13,14,15,21,23,24,26,30,32,34,35,37,41,43,47,49,51,55,60,61,63,65
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
1,4,11,13,14,15,21,23,24,26,30,32,34,35,37,41,43,47,49,51,55,60,61,63,65
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Cold worked components in BWRs are stress relieved although magnitude of benefit not clear.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Subgroup **15.3**

Carbon Steel Welds and HAZ
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
2,3,5,6,8,10,12,16,17,18,20,22,25,27,29,31,33,36,38,40,42,44,46,48,50,52,53,54,56,67,59,62,64,66

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Subgroup **15.3**

Carbon Steel Welds and HAZ
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
2,3,5,6,8,10,12,16,17,18,20,22,25,27,29,31,33,36,38,40,42,44,46,48,50,52,53,54,56,67,59,62,64,66

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.3**

Carbon Steel Welds and HAZ
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
2,3,5,6,8,10,12,16,17,18,20,22,25,27,29,31,33,36,38,40,42,44,46,48,50,52,53,54,56,67,59,62,64,66

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.3**

Carbon Steel Welds and HAZ
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
2,3,5,6,8,10,12,16,17,18,20,22,25,27,29,31,33,36,38,40,42,44,46,48,50,52,53,54,56,67,59,62,64,66

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.3**

Carbon Steel Welds and HAZ
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
2,3,5,6,8,10,12,16,17,18,20,22,25,27,29,31,33,36,38,40,42,44,46,48,50,52,53,54,56,67,59,62,64,66

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.3**

Carbon Steel Welds and HAZ
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
2,3,5,6,8,10,12,16,17,18,20,22,25,27,29,31,33,36,38,40,42,44,46,48,50,52,53,54,56,67,59,62,64,66

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Welds produce high local stresses.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group
15

Engineered Safety Feature System

RHR Normal Shutdown Cooling Piping

Subgroup
15.4

Carbon Steel - Base Metal, Welds and HAZ
Reactor water, stagnant, 550°F, 1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
68-71

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	high cyclic stresses needed, seems unlikely here	
4	Low	High	High	Minimal loading under stagnant water conditions	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	Depends on the supports and input cycles. Not aware of significant failures.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.4** Carbon Steel - Base Metal, Welds and HAZ
Reactor water, stagnant, 550°F, 1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
68-71

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Potential risk of SCC in oxidizing reactor water at high temperature	Depends on water quality and residual stress
3	Low	High	High	high stresses needed, seems unlikely	
4	Low	High	High	Minimal loading under stagnant water conditions	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC possible at these conditions especially with high residual and welding stresses.	
8	Medium	Medium	High	Initially possible , initiating at pits if dynamically loaded. Will decrease with time as O2 decreases	

Group
15

Engineered Safety Feature System

RHR Normal Shutdown Cooling Piping

Subgroup
15.5

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
7,9,19,28,39,45,58,70

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.5**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
7,9,19,28,39,45,58,70
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Limited fatigue in stagnant situation	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Medium	High	High	needs high cyclic stresses; seems likely here	
4	Low	High	High	Generic problem, but stagnant water conditions most of time.	
5	Low	Medium	Medium	Normally stagnant so excessive vibration isn't very likely	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of cyclic load	

Group
15

Engineered Safety Feature System

RHR Normal Shutdown Cooling Piping

Subgroup
15.5

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
7,9,19,28,39,45,58,70

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation only in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.5**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
7,9,19,28,39,45,58,70

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Assuming poor quality in suppression pool. .	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.5**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
7,9,19,28,39,45,58,70

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **15** **Engineered Safety Feature System** **RHR Normal Shutdown Cooling Piping**

Subgroup **15.5**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 120-170°F 275/1140 psia

Applies to BNL Part #s with prefix RHRSHTDWN
7,9,19,28,39,45,58,70

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	Minimal loading under stagnant water conditions	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.1**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRSPRAY
All

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Obviously depends on exposure	
2	Low	High	High	Not an obvious situation in which MIC is expected to flourish.	external surface wetness, nutrients, temperature
3	Low	High	High	a possible concern if surfaces contaminated with deposits, etc.; surfaces must be wet	
4	Low	High	High	Should not be a problem with good practice.	
5	Low	High	High	MIC might be possible here but isn't likely to be a significant problem	external surface wetness, nutrients, temperature
6	Low	High	High	Posible degradation mechanism in this condition depending upon water quality	
7	Low	Medium	Medium	Probably surfaces are clean. However, especially fungal MIC can encure long periods of dryness and then produce acidic sites depending on nutrients. Dissolved CO2 is good nutrient.	
8	Low	Medium	High	Possible if wetted with aerated water (with CO2 nutrient), but unlikely due to intermediate higher temperature	

Subgroup **16.1**

All Carbon Steel Components
External Surfaces When at <150°C
Normally less than 90 °F. Possible as high as 300 °F

Applies to BNL Part #s with prefix RHRSPRAY
All

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Unless surface stays wet a large fraction of the time, pitting should be limited and shallow	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites. Unlikely to affect integrity	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	needs wetted surface at least part of the time	
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	Low	High	High	Potentialproblem only when wetted.	Cl concentration
7	Low	Medium	Medium	Pitting can be expected if the surfaces are wet and contaminated. Such events are probably infrequent.	
8	Low	Medium	High	Assumes that surface really stays dry. If not then score increases to at least 2	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels - Base Metal and Weld
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
2,4,6,8,10,14,18,20,22,24,26,34,38,40,42,44,57,59,61
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels - Base Metal and Weld
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
2,4,6,8,10,14,18,20,22,24,26,34,38,40,42,44,57,59,61
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels - Base Metal and Weld
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
2,4,6,8,10,14,18,20,22,24,26,34,38,40,42,44,57,59,61

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels - Base Metal and Weld
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
2,4,6,8,10,14,18,20,22,24,26,34,38,40,42,44,57,59,61

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality and possible sterilizing effect from periods at higher temperature
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels - Base Metal and Weld
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
2,4,6,8,10,14,18,20,22,24,26,34,38,40,42,44,57,59,61

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.2**

Pipes, Elbows, Tees, Flanges, Valves
Various Carbon Steels - Base Metal and Weld
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
2,4,6,8,10,14,18,20,22,24,26,34,38,40,42,44,57,59,61
Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Cold worked components in BWRs are stress relieved although magnitude of benefit not clear.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.3**

Carbon Steel Weld HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
1,3,5,7,9,11,12,13,15,17,19,21,23,25,27,33,35,57,39,41,43,45,47,49,51,52,56,58,60,64,65,67,69

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.3**

Carbon Steel Weld HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
1,3,5,7,9,11,12,13,15,17,19,21,23,25,27,33,35,57,39,41,43,45,47,49,51,52,56,58,60,64,65,67,69

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	needs high cyclic stresses; seems unlikely here	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	High	Fatigue usage is assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.3**

Carbon Steel Weld HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
1,3,5,7,9,11,12,13,15,17,19,21,23,25,27,33,35,57,39,41,43,45,47,49,51,52,56,58,60,64,65,67,69

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.3**

Carbon Steel Weld HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
1,3,5,7,9,11,12,13,15,17,19,21,23,25,27,33,35,57,39,41,43,45,47,49,51,52,56,58,60,64,65,67,69

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality and possible sterilizing effect from periods at higher temperature
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.3**

Carbon Steel Weld HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
1,3,5,7,9,11,12,13,15,17,19,21,23,25,27,33,35,57,39,41,43,45,47,49,51,52,56,58,60,64,65,67,69

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.3**

Carbon Steel Weld HAZ
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
1,3,5,7,9,11,12,13,15,17,19,21,23,25,27,33,35,57,39,41,43,45,47,49,51,52,56,58,60,64,65,67,69

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Welds produce high local stresses.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.4

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
16,36,53,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	probable in creviced areas	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.4**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
16,36,53,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Limited fatigue in stagnant situation	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Medium	High	High	needs high cyclic stresses; seems likely here	
4	Low	High	High	Generic problem, but stagnant water conditions most of time.	
5	Low	Medium	Medium	Normally stagnant so excessive vibration isn't very likely	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of cyclic load	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.4**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
16,36,53,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreases with exposure time	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation only in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.4**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
16,36,53,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality and possible sterilizing effect from periods at higher temperature
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Medium	High	High	Assuming poor quality in suppression pool. .	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.4**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
16,36,53,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable given stagnant low temperature water	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.4**

Weldolet/ Sockolet
CS SA234 Gr. WPB (etc)
100°F suppression pool water, stagnant
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
16,36,53,71

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stresses and contaminants	
4	Low	High	High	Minimal loading under stagnant water conditions	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.5**

Elbows, Valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
28,30

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposit	Depends on water quality
3	Low	High	High	unlikely in deoxygenated water	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.5

Elbows, Valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
28,30

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Medium	High	High	possible thermal cycling impacts?	
4	Low	High	High	Minimal loading under stagnant water conditions	
5	Low	Medium	Medium	Normally stagnant so fatigue usage should be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.5

Elbows, Valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
28,30

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Negligible with good quality reactor water	Depends on water quality
3	Low	High	High	unlikely in deoxygenated water	
4	Low	High	High	Better quality water and higher temperature mitigating factors.	
5	Low	Medium	High	Probably possible	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Low	Medium	High		

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.5**

Elbows, Valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
28,30

Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High		
2	Low	High	High	Negligible risk at such a high temperature	Depends on water quality when stagnant and time at low temperature
3	0	High	High	MIC not possible at high temperatures	
4	Low	High	High	Better quality water and higher temperature mitigating factors.	
5	0	High	High	Not applicable at this temperature	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	0	Medium	High	Unlikely at this temperature	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.5

Elbows, Valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
28,30

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk in reactor quality water except at inclusions	Depends on water quality
3	Low	High	High	unlikely in deoxygenated water	
4	Low	High	High	Better quality water and higher temperature mitigating factors.	
5	Low	Medium	High	Probably possible	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Low	Medium	High	Relatively unlikely at this elevated temperature	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.5**

Elbows, Valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
28,30

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when highly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High	needs oxidizing conditions and high stress	
4	Low	High	High	Minimal loading under stagnant water conditions	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Cold worked components in BWRs are stress relieved although magnitude of benefit not clear.	
8	Low	Medium	High	Initially possible if a stress source , initiating at pits if dynamically loaded. Will decrease with time as O2 decreases	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.6

Welds and HAZ associated with elbows and valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
29,31,32

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Medium	High	High	possible thermal cycling impacts?	
5	Low	Medium	Medium	Normally stagnant so fatigue usage should be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.6

Welds and HAZ associated with elbows and valves
Various Carbon Steels
Reactor water, stagnant, 550°F

Applies to BNL Part #s with prefix RHRSPRAY
29,31,32

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential susceptibility when highly stressed in oxygenated reactor quality water	Depends on water quality and residual stress
3	Low	High	High	needs oxidizing conditions and high stress	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Welds produce high local stresses.	
8	Medium	Medium	High	Initially possible , initiating at pits if dynamically loaded. Will decrease with time as O2 decreases	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.7**

Spray header in containment, Tee, Reducer and Welds, Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
46,47,48,49

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.7**

Spray header in containment, Tee, Reducer and Welds, Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
46,47,48,49

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	used infrequently; probably insufficient cyclic stress accumulation	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	Medium	Normally stagnant so excessive vibration isn't very likely	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Unclear source of cyclic load	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.7

Spray header in containment, Tee, Reducer and Welds, Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
46,47,48,49

Notes: Only replaced with condensate water prior to shutdown cooling mode.

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.7**

Spray header in containment, Tee, Reducer and Welds, Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
46,47,48,49

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality and possible sterilizing effect from periods at higher temperature
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Low	Medium	Medium	High flow rates minimize the MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.7**

Spray header in containment, Tee, Reducer and Welds, Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
46,47,48,49

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.7**

Spray header in containment, Tee, Reducer and Welds, Various Carbon Steels
100°F suppression pool water, stagnant.
Reactor water flow rate 7450 gpm, 125-334°F, 275 psi operating once a cycle

Applies to BNL Part #s with prefix RHRSPRAY
46,47,48,49

Notes: Only replaced with condensate water prior to shutdown cooling mode.

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs oxidizing conditions and high stress	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC occurs in this range of temperatures and oxygen concentration. Welds produce high local stresses.	
8	Medium	Medium	High	Possible at these temps if in poor purity water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.8**

Spray header in drywell
Tee, Reducer and Welds
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
50,51,52

Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	With deposits accumulating on bottom of pipes, crevices will be extensive and all forms of corrosion are possible. Rate would be highly variable	
8	Medium	High	High	Geometric crevices or under-deposit	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.8**

Spray header in drywell
Tee, Reducer and Welds
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
50,51,52

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	infrequent operation	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	Medium	Fatigue usage factor assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	Medium	Medium	Depends on design and cyclic stressing. Sufficient stress intensification and applied stress cycling is probably sufficient for some FAT.	
8	Low	Medium	High	Unclear source of cyclic load	

Subgroup **16.8**

Spray header in drywell
Tee, Reducer and Welds
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
50,51,52

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	Medium water quality and oxygen will lead to general corrosion	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.8**

Spray header in drywell
Tee, Reducer and Welds
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
50,51,52
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	Conditions good for MIC	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.8**

Spray header in drywell
Tee, Reducer and Welds
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
50,51,52

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Pitting is certain owing to deposits, medium water quality, oxygen	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.8**

Spray header in drywell
Tee, Reducer and Welds
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
50,51,52

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stress and oxidizing conditions	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water residuals present.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions. Unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Possible at these temps if in poor purity water, but unlikely if deoxygenated	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.9**

Sockolet in spray header in drywell
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
53
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Subgroup **16.9**

Sockolet in spray header in drywell
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
53
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Sockolets often suffer from fatigue problems; unclear whether there is significant fatigue here	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Low	High	High	infrequent operation	
4	Low	High	High	Should be within design criteria.	
5	Medium	Medium	Medium	Fatigue damage due to vibration loading has been observed for some socket welds. Not clear if excessive vibration is likely here	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of cyclic load	

Subgroup **16.9**

Sockolet in spray header in drywell
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
53
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.9**

Sockolet in spray header in drywell
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
53
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.9**

Sockolet in spray header in drywell
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
53
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.9**

Sockolet in spray header in drywell
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
53
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stress and oxidizing conditions	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water residuals present.	
5	Low	Medium	High	SCC not likely for C-steel under these conditions. Unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Low	Medium	High	Possible at these temps if in poor purity water, but unlikely if deoxygenated	

Subgroup **16.10**

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present/galvanic couple a concern	
4	Medium	High	High	Geometrical crevices possible.	
5	Medium	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	High	High	High	Geometric crevices in conjunction with galvanic attack	

Subgroup **16.10**

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Sockolets often suffer from fatigue problems; unclear whether there is significant fatigue here	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Low	High	High	infrequent operation	
4	Low	High	High	Generic problem, but stagnant conditions most of time.	
5	Medium	Medium	Medium	Fatigue damage due to vibration loading has been observed for some socket welds. Not clear if excessive vibration is likely here	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of cyclic load	

Subgroup **16.10**

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

Galvanic Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Severity of crev corrosion depends on water purity	
2	High	High	High	Hard to imagine a more unfavorable combination if exposed to poor quality water from Suppression Pool	Depends on water conductivity
3	High	High	High	brass coupled to carbon steel results in accelerated corrosion of carbon steel if component wetted	
4	High	High	High	Unfortunate material combination and poor water quality	
5	High	High	High	Galvanic corrosion appears almosr certain here	Depends on water conductivity
6	Low	High	High	Potential problen in these combination of materials	Oxygen entry can be critical
7	Medium	Medium	Medium	A joint of brass and carbon steel is a very bad combination under almost any circumstance	
8	High	Medium	High	Very likely if impure suppression pool water is retained in this subcomponent following intermittent operation	

Subgroup **16.10**

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	significant concern in galvanic couple such as this	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup
16.10

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.10**

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present, especially in area of galvanic couple	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.10**

Sockolet in spray header in drywell
Carbon Steel - Brass joint
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
54
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Medium	High	High	needs high stress and oxidizing conditions/galvanic couple a concern	
4	Medium	High	High	Poor quality water residuals present which could affect brass.	
5	Low	Medium	High	SCC not likely for C-steel under these conditions. Unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field. Brass provides a galvanic connection that could accelerate several types of	
8	Low	Medium	High	Possible at these temps if in poor purity water, but unlikely if deoxygenated	

Subgroup **16.11**

Spray header in drywell
Brass Nozzle
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
55
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Not likely on more noble metal	
3	Medium	High	High	possible in tight joints, under deposits	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and oxygenated water.	
8	Low	High	High		

Subgroup **16.11**

Spray header in drywell
Brass Nozzle
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
55
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	infrequent operation	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	Medium	CUF assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	High	High	FAT minimum owing to infrequent use.	
8	Low	Medium	High	Unclear source of cyclic load	

Subgroup **16.11**

Spray header in drywell
Brass Nozzle
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
55
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Dezincification possible assuming long term contact with poor water quality from suppression pool	Depends on water quality
3	Low	High	High	unlikely	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.11**

Spray header in drywell
Brass Nozzle
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
55
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Not likely on Cu bearing alloy	
3	0	High	High	copper alloys resistant to most forms of MIC	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Low	Medium	Medium	Possible during period exposed to suppression pool water.	

Subgroup **16.11**

Spray header in drywell
Brass Nozzle
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
55
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	unlikely but possible under deposits	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.11**

Spray header in drywell
Brass Nozzle
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
55
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Dezincification possible, assuming long term exposure to poor water quality from suppression pool, leading to brittle cracking	Depends on water quality and residual stress
3	Low	High	High	unlikely; SCC requires corrosive species such as ammonia	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water residuals present.	
5	Low	Medium	Medium	SCC seems unlikely here	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These have weld stresses.	
8	Low	Medium	High	Not likely in brass unless poor purity water, but unlikely if deoxygenated	

Subgroup **16.12**

Spray header above the suppression pool
Pipes, Elbows, Tees, Welds
Various Carbon Steels
100°F suppression pool water

Applies to BNL Part #s with prefix RHRSPRAY
62,63,64,65,66,67,68,69,70
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and oxygenated water.	
8	Medium	High	High	Geometric crevices or under-deposit	

Subgroup **16.12**

Spray header above the suppression pool
Pipes, Elbows, Tees, Welds
Various Carbon Steels
100°F suppression pool water

Applies to BNL Part #s with prefix RHRSPRAY
62,63,64,65,66,67,68,69,70
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	infrequent operation	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	Medium	Fatigue usage factor assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	High	High	FAT minimum owing to infrequent use.	
8	Low	Medium	High	Unclear source of sustained cyclic load	

Subgroup **16.12**

Spray header above the suppression pool
Pipes, Elbows, Tees, Welds
Various Carbon Steels
100°F suppression pool water

Applies to BNL Part #s with prefix RHRSPRAY
62,63,64,65,66,67,68,69,70
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.12**

Spray header above the suppression pool
Pipes, Elbows, Tees, Welds
Various Carbon Steels
100°F suppression pool water

Applies to BNL Part #s with prefix RHRSPRAY
62,63,64,65,66,67,68,69,70
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Probable due to poor quality and stagnant water and oxygen in suppression pool water.	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.12**

Spray header above the suppression pool
Pipes, Elbows, Tees, Welds
Various Carbon Steels
100°F suppression pool water

Applies to BNL Part #s with prefix RHRSPRAY
62,63,64,65,66,67,68,69,70
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	Medium	Medium	Probable due to poor purity water plus oxygen in suppression pool water. Will depend on oxygen content (associated with corrosion of carbon steel).	
5	Medium	High	High	Suppression pool water is usually poorly controlled	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.12**

Spray header above the suppression pool
Pipes, Elbows, Tees, Welds
Various Carbon Steels
100°F suppression pool water

Applies to BNL Part #s with prefix RHRSPRAY
62,63,64,65,66,67,68,69,70
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stress and oxidizing conditions	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water much of the time.	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These have weld stresses and possibly residual stresses from fabrication.	
8	Low	Medium	High	Possible at these temps if in poor purity water	

Subgroup **16.13**

Sockolet spray header above the suppression pool
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
71
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices or under-deposit	

Subgroup **16.13**

Sockolet spray header above the suppression pool
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
71
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Sockolets often suffer from fatigue problems; unclear whether there is significant fatigue here	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Low	High	High	infrequent operation	
4	Low	High	High	Generic problem, but stagnant conditions most of time.	
5	Medium	Medium	Medium	Fatigue damage due to vibration loading has been observed for some socket welds. Not clear if excessive vibration is likely here	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of sustained cyclic load	

Subgroup **16.13**

Sockolet spray header above the suppression pool
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
71
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water which will not be dried out during majority of time	

Subgroup **16.13**

Sockolet spray header above the suppression pool
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
71
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.13**

Sockolet spray header above the suppression pool
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
71
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water	

Subgroup **16.13**

Sockolet spray header above the suppression pool
Carbon Steel SA234 Gr. WPB
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
71
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stress and oxidizing conditions	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water residuals present.	
5	Low	Medium	High	SCC not likely for C-steel under these conditions. Unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Low	Medium	High	Possible at these temps if in poor purity water, but unlikely given majority of time in n2	

Group **16** **Engineered Safety Feature System** **RHR Spray Piping**

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and high oxygenated flow.	
8	Medium	High	High	Geometric crevices in conjunction with galvanic attack	

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Sockolets often suffer from fatigue problems; unclear whether there is significant fatigue here	
2	Medium	High	Medium	Flow induced vibration a risk in these components	Cyclic loading, socket weld design, fabrication defects
3	Low	High	High	infrequent operation	
4	Low	High	High	Generic problem, but stagnant conditions most of time.	
5	Medium	Medium	Medium	Fatigue damage due to vibration loading has been observed for some socket welds. Not clear if excessive vibration is likely here	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Unclear source of cyclic load	

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

Galvanic Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Severity of crev corrosion depends on water purity	
2	High	High	High	Hard to imagine a more unfavorable combination if exposed to poor quality water from Suppression Pool	Depends on water conductivity
3	High	High	High	brass coupled to carbon steel results in accelerated corrosion of carbon steel if component wetted	
4	High	High	High	Unfortunate material combination and poor water quality	
5	High	High	High	Galvanic corrosion appears almosr certain here	Depends on water conductivity
6	Low	High	High	Potential problen in these combination of materials	Oxygen entry can be critical
7	Medium	Medium	Medium	A joint of brass and carbon steel is a very bad combination under almost any circumstance	
8	High	Medium	High	Very likely if impure suppression pool water is retained in this subcomponent following intermittent operation	

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water. Depends on extent of drying out	

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water. Depends on extent of drying out	

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water. Depends on extent of drying out	

Subgroup **16.14**

Sockolet spray header above the suppression pool
Carbon Steel - Brass joint (drywell)
N2 (when plant is operating)
100F suppression pool water when spraying

Applies to BNL Part #s with prefix RHRSPRAY
72
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stress and oxidizing conditions	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water residuals present.	
5	Low	Medium	High	SCC not likely for C-steel under these conditions. Unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field. Brass provides a galvanic connection that could accelerate several types of	
8	Low	Medium	High	Possible at these temps if in poor purity water, but unlikely if deoxygenated	

Subgroup
16.15

Spray header above the suppression pool
Nozzle Drywell
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
73
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Medium	High	High	possible in creviced areas when suppression pool water present	
4	Low	High	High	Geometrical crevices possible.	
5	Low	Medium	High	Probably possible but unlikely to be dominant here	
6	Medium	High	High	Geometric crevices or under-deposit	
7	Medium	Medium	Medium	CREV occurs owing to deposits from iron oxides and oxygenated water.	
8	Medium	High	High	Geometric crevices in conjunction with galvanic attack	

Subgroup **16.15**

Spray header above the suppression pool
Nozzle Drywell
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
73
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable	Cyclic loading
3	Low	High	High	infrequent operation	
4	Low	High	High	Should be within design criteria.	
5	Low	Medium	Medium	CUF assumed to be low	
6	Low	High	High	Fatigue loading assumed minor.	Cyclic stress
7	Low	High	High	FAT minimum owing to infrequent use.	
8	Low	Medium	High	Unclear source of cyclic load	

Subgroup **16.15**

Spray header above the suppression pool
Nozzle Drywell
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
73
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Low	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Low	High	High	high initially but decreasing with exposure to the stagnant water	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Possible degradation in oxygenated water	
7	Medium	Medium	Medium	GC occurs owing to oxygen presence.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water. Depends on extent of drying out	

Subgroup **16.15**

Spray header above the suppression pool
Nozzle Drywell
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
73
Notes:

Microbiologically Induced Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor quality from suppression pool.	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Assuming poor quality in suppression pool.	
7	Medium	Medium	Medium	MIC favored in low flows, oxygen, nutrients.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water. Depends on extent of drying out	

Group
16

Engineered Safety Feature System

RHR Spray Piping

Subgroup
16.15

Spray header above the suppression pool
Nozzle Drywell
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
73
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High	probable when suppression pool water present	
4	Medium	High	High	Residual poor quality water will remain in system despite presence of nitrogen when plant operating.	
5	Medium	High	High	Suppression pool water is usually poorly controlled; unclear whether header fully dries out	
6	Low	High	High	Unlikely in deoxygenated water without Cl	Surface finish, Geometry and deposit of corrosion product
7	Medium	Medium	Medium	Oxygen accelerate pitting.	
8	Medium	Medium	Medium	Possible during period exposed to suppression pool water. Depends on extent of drying out	

Subgroup **16.15**

Spray header above the suppression pool
Nozzle Drywell
N2 (when plant is operating)
100°F suppression pool water in operating mode

Applies to BNL Part #s with prefix RHRSPRAY
73
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming poor water quality from suppression pool	Depends on water quality and residual stress
3	Low	High	High	needs high stress and oxidizing conditions	
4	Low	High	High	SCC unlikely at this low temperature, even though poor quality water residuals present.	
5	Low	Medium	Medium	SCC seems unlikely here	
6	Low	High	High	Assuming poor quality in suppression pool	Hardening and stress
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These have weld stresses and possibly residual stresses from fabrication.	
8	Low	Medium	High	Possible at these temps if in poor purity water, but unlikely if deoxygenated	

Subgroup **17.1**

All carbon and low-alloy steel components
External surfaces (normally dry)
<547°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
Allexcept 21,72,74
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Concern for fatigue because a support "saddle" is used on the equalizing header	
2	Medium	High	High	Concern for fatigue due to a support "saddle" used on the equalizing header	Fillet welds between reinforcement and pipe
3	Medium	High	High	Concern for fatigue because a support "saddle" is used on the equalizing header	
4	Medium	High	High	Concern for fatigue because a support "saddle" is used on the equalizing header	
5	Low	Medium	High	Concern for fatigue because of some design features but field experience has been good as far as I know	Design of support "saddle"
6	Medium	High	High	Concern for fatigue because a support "saddle" is used on the equalizing header	
7	Low	Medium	Medium	Fatigue failures can be initiated from the outside surface but they would not be associated with an environment. Such failures seem generally not likely owing to the persistent dryness. The geometry of the steam equalization may produce stress intensifi	
8	Medium	High	High	Concern for fatigue because a support "saddle" is used on the equalizing header	

Subgroup **17.1**

All carbon and low-alloy steel components
External surfaces (normally dry)
<547°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
Allexcept 21,72,74
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
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	High	High		
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	High	High	Well-known phenomenon that requires deposits and/or insulation impurities	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	Low	High	High		
7	0	High	High	There is an exception here. If the surface is dry as noted, then no pitting. If the surface is wet, then the length of time and contaminants are important.	
8	Low	Medium	High	Assumes that surface really stays dry. If not then score increases to at least 2	

Group
17

Steam and Power Conversion System

Main Steam

Subgroup
17.1

All carbon and low-alloy steel components
External surfaces (normally dry)
<547°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
Allexcept 21,72,74
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	0	High	High		
2	0	High	High	No known external SCC mechanisms	
3	0	High	High		
4	Low	High	High	Only a problem if wet for longer periods, in particular in presence of chlorides.	
5	Low	Medium	Medium	Potentially possible at and near welds	Impurities (chlorides, sulfides, copper, etc) required, plus moisture
6	0	High	High		
7	0	High	High	There is an exception here. If the surface is dry as noted, then no SCC. If the surface is wet, then the length of time and contaminants are important.	
8	0	High	High	Unlikely, but depends on exact composition of aqueous environment that might form	

Subgroup **17.2**

Main steam carbon steel seam or seamless pipes, forgings, castings, fittings and weldments
A106B, A234, A105, A216, A672B70
High flow rate saturated steam (<0.25% moisture)
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
1-7,14-20,22-33,36,37,48-53,57-64
Notes: No effect of HWC here

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Droplet abrasion	
2	Medium	High	High	Droplet erosion	Steam quality and velocity
3	Medium	High	High	Droplet abrasion	
4	Medium	High	High	Droplet abrasion	
5	Low	Medium	High	Possible, but not as problematic as FAC	
6	Medium	High	High	Droplet abrasion	
7	--	--	--	In view of the FAC the EC does not make sense here	
8	Medium	High	High	Droplet abrasion	

Subgroup **17.2**

Main steam carbon steel seam or seamless pipes, forgings, castings, fittings and weldments
A106B, A234, A105, A216, A672B70
High flow rate saturated steam (<0.25% moisture)
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
1-7,14-20,22-33,36,37,48-53,57-64

Notes: No effect of HWC here

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Flow assisted corrosion of water film	
2	Medium	High	High	Flow assisted corrosion by surface water film	Velocity, oxygen content of water film and Cr content of carbon steels
3	Medium	High	High	Flow assisted corrosion of water film	
4	Medium	High	High	Flow assisted corrosion of water film	
5	Medium	High	High	Well-known phenomenon. Pipe wall-thickness measurements indicate that some thinning can occur but field experience has generally been good	Trace element content of c-steel and local moisture content of steam are key variables
6	Medium	High	High	Flow assisted corrosion of water film	
7	Low	Medium	Medium	The occurrence of EC is intensified as the oxidizing conditions are increased, e.g. by adding oxygen and by adjusting the pH to that of minimum solubility. EC is also decreased by using more Cr in alloys.	
8	Medium	High	High	Tiger striping. Susceptibility score would be 3 if moisture content higher	

Subgroup **17.2**

Main steam carbon steel seam or seamless pipes, forgings, castings, fittings and weldments
A106B, A234, A105, A216, A672B70
High flow rate saturated steam (<0.25% moisture)
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
1-7,14-20,22-33,36,37,48-53,57-64
Notes: No effect of HWC here

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Good field experience so far but a few failures attributed to fatigue have occurred. Flow induced vibration always a potential problem.	Excessive vibration. Degradation probably is most likely in attached branch lines
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Good field experience but a few failures attributed to fatigue have occurred	Excessive vibration is the key driver and is most likely in small-diameter weldolets and branch lines
6	Low	High	High	Cyclic loading is not significant	
7	Low	Medium	Medium	The occurrence of FAT depends on the magnitude and frequency of the cyclic stresses.	
8	Low	High	High		

Subgroup **17.2**

Main steam carbon steel seam or seamless pipes, forgings, castings, fittings and weldments
A106B, A234, A105, A216, A672B70
High flow rate saturated steam (<0.25% moisture)
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
1-7,14-20,22-33,36,37,48-53,57-64
Notes: No effect of HWC here

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC if oxygenated condensate can accumulate and residual stress high	Presence of oxygenated condensate and high residual welding and/or fit-up stress
3	Low	High	High		
4	Low	High	High	Good service experience	
5	Low	High	High	Not likely to occur, in my opinion	
6	Low	High	High	Unlikely in this condition	
7	Medium	Medium	Medium		
8	Medium	High	High	Expected if dynamic loading component	

Subgroup **17.3**

SRV and discharge lines, seamless carbon steel pipes, forgings, fittings, flanges
A234, A106, A105
No effect of HWC here

Applies to BNL Part #s with prefix MS
65-71,75

Notes: Almost always moist nitrogen; Saturated steam when SRV opens
Moist N2 or steam at 14 psi; 547°F, 1020 psia when SRV opens

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Good field experience. Flow induced vibration always a potential problem but infrequent use of SRV discharge line means low risk, in principle.	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines
3	Low	High	High		
4	Medium	High	High	Transient loading conditions difficult to predict	
5	Low	Medium	High	Fatigue usage is assumed to be low to moderate	
6	Low	High	High	Cyclic loading is not significant	
7	0	Medium	Medium	SRV does not operate except rarely. However, the inside surfaces are exposed and would be subjected to the usual modes of corrosion	
8	Low	Medium	High	Uncertain definition of cyclic loading	

Subgroup **17.3**

SRV and discharge lines, seamless carbon steel pipes, forgings, fittings, flanges
A234, A106, A105
No effect of HWC here

Applies to BNL Part #s with prefix MS
65-71,75

Notes: Almost always moist nitrogen; Saturated steam when SRV opens
Moist N2 or steam at 14 psi; 547°F, 1020 psia when SRV opens

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC where oxygenated condensate can accumulate and residual stress high	Presence of oxygenated condensate and high residual welding and/or fit-up stress
3	Low	High	High		
4	Low	High	High	Good service experience	
5	Low	High	High	SCC is not very likely for C-steels under these conditions	
6	Low	High	High	Unlikely in moist nitrogen.	
7	Low	Medium	Medium	Some SCC is possible owing to the oxygen. Especially the higher strength materials would be prone to SCC but the CS is also. Failures of SRVs seem infrequent	
8	Low	Medium	High	Unlikely in an effective dearated moisture film environment (Unclear tensile stress)	

Group **17** **Steam and Power Conversion System** **Main Steam**

Subgroup **17.4**

Weldolet pipe/weld/flange
A234, A106, A105
Saturated steam (<0.25% moisture) in dead leg
547°F, 1020 psia
No effect of HWC here

Applies to BNL Part #s with prefix MS
8-13,34,35,38-41

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Sockolets often have fatigue issues; unclear whether fatigue loading exists here	
2	Medium	Medium	Medium	Good field experience so far. Flow induced vibration always a potential problem.	Excessive vibration. Degradation probably is most likely in small-diameter weldolets and branch lines
3	Medium	Medium	Medium		
4	Medium	Medium	Medium	Generic problem for weldolets	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	Medium	Medium	Effects of ripple stress is concern	
7	Medium	Medium	Medium	Weldolets sustain high stresses and are attached at one end to a robust sturdy member at and the other to a light flexible pipe. The intersection of these produces high stresses at the joint.	
8	Medium	Medium	Medium	Likely mechanical cyclic loading	

Subgroup **17.4**

Weldolet pipe/weld/flange
A234, A106, A105
Saturated steam (<0.25% moisture) in dead leg
547°F, 1020 psia
No effect of HWC here

Applies to BNL Part #s with prefix MS
8-13,34,35,38-41
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Risk of SCC where oxygenated condensate can accumulate and residual stress high	Presence of oxygenated condensate and high residual welding and/or fit-up stress
3	Medium	High	High		
4	Medium	High	High	Deadleg conditions	
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Medium	High	High	Concern for fatigue because a potential cyclic loading.	
7	Medium	Medium	Medium	Stresses at the weldolet are high because of bending at this joint, residual welding stresses. Oxygen and moisture are sufficient to supply the environment.	
8	Medium	High	High		

Subgroup **17.5**

Low alloy steel bolts for tee quencher/sparger, A540 B21 (Hatch 2)
Immersed in suppression pool water possibly with Zn primer
Normally <90°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
73
Notes:

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Geometric crevices or under-deposits	Depends on water quality
3	Low	High	High		
4	Low	High	High	Poor quality water	
5	Low	High	High	Depends on suppression pool water quality	
6	Low	High	High		
7	High	Medium	Medium	Crevices will exist at joints joined by the bolts. CREV can be expected and this will also contribute to stresses from expansion of corrosion products.	
8	Low	High	High		

Subgroup **17.5**

Low alloy steel bolts for tee quencher/sparger, A540 B21 (Hatch 2)
Immersed in suppression pool water possibly with Zn primer
Normally <90°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
73
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium		
2	Low	High	High	No known fatigue issues but could be a potential degradation mode	Good service experience to date but CUFs not available.
3	Low	Medium	Medium		
4	Low	Medium	Medium	Loading conditions poorly defined	
5	Low	Medium	Medium	Fatigue usage is assumed to be low to moderate	
6	Low	Medium	Medium	Potential degradation mode	
7	Medium	Medium	Medium	Corrosion fatigue of high strength bolts should be aggressive.	
8	Low	Medium	Medium	Uncertain cyclic loading	

Group **17** **Steam and Power Conversion System** **Main Steam**

Subgroup **17.5**

Low alloy steel bolts for tee quencher/sparger, A540 B21 (Hatch 2)
Immersed in suppression pool water possibly with Zn primer
Normally <90°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
73
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Assuming poor water quality from suppression pool	Depends on water quality
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Medium	Medium	High	Apparently has occurred but not sure that this is generic	
6	Medium	High	High		
7	High	Medium	Medium	Pitting is certain owing to deposits, poor water quality, oxygen. The pitting will increase the proneness to SCC.	
8	Medium	High	High		

Subgroup **17.5**

Low alloy steel bolts for tee quencher/sparger, A540 B21 (Hatch 2)
Immersed in suppression pool water possibly with Zn primer
Normally <90°F
No effect of HWC here

Applies to BNL Part #s with prefix MS
73
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	High	High	Medium		
2	High	High	Medium	Has occurred but requires moisture and excessive out-of-specification metal hardness	Bolt hardness
3	High	High	Medium		
4	High	High	Medium	Poor quality water	
5	Medium	Medium	Medium	Apparently has occurred but not sure that this is generic	
6	High	High	Medium	Field experience of failure in quencher.	
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	High	High	Medium	Very likely if Zn paint used	

Group **17** **Steam and Power Conversion System** **Main Steam**

Subgroup **17.6**

SRV discharge line in suppression pool and tee quencher/sparger
Austenitic stainless steel plus bimetallic joint above water level
When SRVs open, steam is 547°F, 1020 psia

Applies to BNL Part #s with prefix MS
72,74

Notes: Suppression pool water almost always; saturated steam when in use
No effect of HWC here

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Possible if crevices exist in suppression pool with poor water quality	Presence of crevices and water quality (plus dissolved oxygen)
3	Medium	High	High		
4	Medium	High	High	Poor quality water	
5	Low	High	High	Depends on suppression pool water quality	
6	Medium	High	High		
7	Low	Medium	Medium	System rarely used but oxygenated water present and would produce CREV.	
8	Medium	High	High	Moist , condensing environment	

Subgroup **17.6**

SRV discharge line in suppression pool and tee quencher/sparger
Austenitic stainless steel plus bimetallic joint above water level
When SRVs open, steam is 547°F, 1020 psia

Applies to BNL Part #s with prefix MS
72,74

Notes: Suppression pool water almost always; saturated steam when in use
No effect of HWC here

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	Medium	Medium		
4	Low	Medium	Medium	Loading conditions poorly defined	
5	Low	Medium	Medium	Fatigue usage is assumed to be low to moderate	
6	Low	Medium	Medium	Potential degradation mode	
7	0	Medium	Medium	This discharge line is rarely used and there would be no opportunity for fatigue	
8	Low	Medium	Medium	Uncertain mechanical cyclic loading	

Subgroup **17.6**

SRV discharge line in suppression pool and tee quencher/sparger
Austenitic stainless steel plus bimetallic joint above water level
When SRVs open, steam is 547°F, 1020 psia

Applies to BNL Part #s with prefix MS
72,74

Notes: Suppression pool water almost always; saturated steam when in use
No effect of HWC here

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Depends on quality of suppression pool water	
2	Medium	High	High	Significant risk in poor quality Suppression Pool water.	Depends on water quality
3	Medium	High	High	susceptibility based on possible poor water quality; dissimilar joint susceptible when wetted	
4	Low	High	High	Poor water qaulity most of the time. Remainder of time oxygenated water.	
5	Medium	High	High	Likely to occur if Suppression Pool water quality is poor.	Water quality
6	Low	High	High	It can be a problem when steam is wet.	
7	Low	Medium	Medium	Possibly some pitting owing to presence of oxygen and probably uncontrolled water chemistry	
8	Low	Medium	High	Possible if chloride present	

Subgroup **17.6**

SRV discharge line in suppression pool and tee quencher/sparger
Austenitic stainless steel plus bimetallic joint above water level
When SRVs open, steam is 547°F, 1020 psia

Applies to BNL Part #s with prefix MS
72,74

Notes: Suppression pool water almost always; saturated steam when in use
No effect of HWC here

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC if significantly cold worked or sensitized	Cold work and sensitization
3	Low	High	High		
4	Low	High	High	Intermittent use, so mitigating loading conditions	
5	Low	High	High	Depends on suppression pool water quality	
6	Low	High	High	Unlikely in this condition	
7	0	Medium	Medium	no SCC in SS for this temperature range	
8	Low	High	High		

Group **17** **Steam and Power Conversion System** **Main Steam**

Subgroup **17.7**

CASS, A351 Type 304, Venturi flow restrictor in steam line to limit flow to 200% if failure
High flow rate saturated steam (<0.25% moisture) at 100% power
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
21

Notes: No effect of HWC here

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Stainless steels not immune from steam droplet erosion if velocity sufficiently high	Steam quality and velocity
3	Low	High	High		
4	Low	High	High	Droplet abrasion possible	
5	Low	Medium	High	Models exist -- should be possible to predict	
6	Low	High	High	The materials are in geneal resistant to EC.	
7	Low	Medium	Medium	Little use but EC expected when release of steam.	
8	Low	High	High	Not likely to be a problem with the austenitic alloys	

Subgroup
17.7

CASS, A351 Type 304, Venturi flow restrictor in steam line to limit flow to 200% if failure
High flow rate saturated steam (<0.25% moisture) at 100% power
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
21

Notes: No effect of HWC here

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium		
2	Low	Medium	Medium	Fatigue loading assumed to be within code allowable.	Effects of wet steam on CASS corrosion fatigue not known
3	Low	Medium	Medium		
4	Medium	Medium	Medium	Loading conditions poorly defined	
5	Low	Medium	Medium	Fatigue usage is assumed to be low to moderate	
6	Low	Medium	Medium	Potential degradation mode	
7	0	Medium	Medium	Little use and little stress cycles	
8	Medium	Medium	Medium	Should be a possibility of flow induced vibration	

Subgroup **17.7**

CASS, A351 Type 304, Venturi flow restrictor in steam line to limit flow to 200% if failure
High flow rate saturated steam (<0.25% moisture) at 100% power
547°F, 1020 psia

Applies to BNL Part #s with prefix MS
21

Notes: No effect of HWC here

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Medium	High	High	Loss of fracture toughness inevitable at 547°F. Eventual toughness very dependent on heat to heat variability	CASS composition, especially Cr equivalent and ferrite content
3	Medium	High	High		
4	Medium	Medium	Medium	Insufficient data, but lab indications, could be a problem.	
5	Medium	High	High	Models exist -- should be possible to predict extent of thermal embrittlement. No in-environment toughness test data.	
6	Medium	High	High	Thermak agin is a potential cause of reduction of FR	
7	Low	Medium	Medium	Little use and probably overdesigned.	
8	Medium	Medium	High	Uncertain effect of environment on toughness	

Subgroup **18.1**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
6061-T6 & other Al alloys
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58
Notes: HWC not relevant to CCST water

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Reputed to be a resistant alloy in such conditions	
3	Low	High	High	can occur under deposits	
4	Low	High	High		
5	Low	Medium	High	Service conditions shouldn't pose a major threat to Al alloys	
6	Low	High	High	Potential degradation depending upon geometries and corrosion products	
7	Low	High	High		
8	Low	Medium	High		

Group **18** **Engineered Safety Feature System** **Cycled Condensate Storage Tank**

Subgroup **18.1**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
6061-T6 & other Al alloys
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58

Notes: HWC not relevant to CCST water

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed minor	
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Fatigue usage should be low	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	High	High	Fatigue loading assumed minor	
8	Low	High	High	Fatigue loading assumed minor	

Subgroup **18.1**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
6061-T6 & other Al alloys
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58

Notes: HWC not relevant to CCST water

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Reputed to be a resistant alloy in such conditions	
3	Low	High	High	can occur under deposits	
4	Low	High	High		
5	Low	Medium	High	Service conditions shouldn't pose a major threat to Al alloys	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	High	High		
8	Low	Medium	High	Would be a potential problem if chloride contamination	

Group **18** **Engineered Safety Feature System** **Cycled Condensate Storage Tank**

Subgroup **18.1**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
6061-T6 & other Al alloys
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58
Notes: HWC not relevant to CCST water

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Reputed to be a resistant alloy in such conditions	
3	Low	High	High	this alloy very resistant to SCC	
4	Low	High	High		
5	Low	Medium	High	Service conditions shouldn't pose a major threat to Al alloys	
6	Low	High	High	Unlikely in this water.	Water purity
7	Low	High	High		
8	Low	High	High	SCC not a problem in this environment/ temperature combination	

Subgroup **18.2**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
Stainless steel (OTHER PLANT)
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58

Notes: HWC not relevant to CCST water

Crevice Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	Medium	Assuming air-saturated water	Water purity
3	Low	High	High	can occur under deposits	
4	Low	High	High		
6	Low	High	High	Geometries and corrosion products	
7	0	High	High	No issue here	
8	Low	Medium	High		

Subgroup **18.2**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
Stainless steel (OTHER PLANT)
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58

Notes: HWC not relevant to CCST water

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed minor	
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	High	High	Fatigue loading assumed minor	
8	Low	High	High	Fatigue loading assumed minor	

Group **18** **Engineered Safety Feature System** **Cycled Condensate Storage Tank**

Subgroup **18.2**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
Stainless steel (OTHER PLANT)
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58

Notes: HWC not relevant to CCST water

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Assuming air-saturated water	Water purity
3	Low	High	High	can occur under deposits	
4	Low	High	High		
6	Low	High	High	Cl may cause pitting	Water purity
7	0	High	High	No issue here	
8	Low	Medium	High	Would be a potential problem if chloride contamination	

Subgroup **18.2**

Various plates, pipes, angles, shells, flanges, nozzles, vents, columns, gussets
Stainless steel (OTHER PLANT)
100°F demineralized water, aerated

Applies to BNL Part #s with prefix CCST
1-58

Notes: HWC not relevant to CCST water

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low temperature	
3	Low	High	High	likely low stresses and low risk at these temperatures	
4	Low	High	High		
6	Low	High	High	Unlikely in this water	Water purity and cold work
7	0	High	High	No issue here	
8	Low	High	High	Would be a potential problem if chloride contamination	

Subgroup **19.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC

Applies to BNL Part #s with prefix FW
1-7,9-25,27-31,33-38,40-43,45-48,50-61,63-71,73-76,78-79,81-101,103-107
Notes: HWC not relevant to most feedwater

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	FAC controlled by oxygen injection, otherwise potentially very vulnerable	Efficiency of oxygen injection equipment
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Has been a problem in the past but shouldn't be a problem if the oxygen level is maintained	
6	Medium	High	High	Potential dengaradation mode in CS	Local flow velocity
8	Low	High	High	Risk will be small if oxygenation specs met.	

Group **19** **Steam and Power Conversion System** **Feedwater**

Subgroup **19.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC

Applies to BNL Part #s with prefix FW
1-7,9-25,27-31,33-38,40-43,45-48,50-61,63-71,73-76,78-79,81-101,103-107

Notes: HWC not relevant to most feedwater

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed minor and within code allowable	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	Fatigue minor but possible in these complex geometries that are in use during operation.	
8	Low	Medium	High	Fatigue loading assumed minor	

Group **19** **Steam and Power Conversion System** **Feedwater**

Subgroup **19.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC

Applies to BNL Part #s with prefix FW
1-7,9-25,27-31,33-38,40-43,45-48,50-61,63-71,73-76,78-79,81-101,103-107
Notes: HWC not relevant to most feedwater

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium		
8	Medium	High	High	Can be a problem during low temp. aerated layup	

Subgroup **19.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC

Applies to BNL Part #s with prefix FW
1-7,9-25,27-31,33-38,40-43,45-48,50-61,63-71,73-76,78-79,81-101,103-107
Notes: HWC not relevant to most feedwater

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential SCC susceptibility at high potential	Oxygen content, water quality, cold work, residual stress
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Unlikely in this water.	Water purity
7	Medium	Medium	Medium	SCC occurs readily in this range of temperatures and oxygen. Welds on plates and cold work would exacerbate.	
8	Medium	Medium	High	Can be a problem if dynamic loading due to startup etc.	

Subgroup **19.2**

Valves
Carbon Steel - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
8,26,32,44,62,72,80
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	FAC controlled by oxygen injection, otherwise potentially very vulnerable	Efficiency of oxygen injection equipment
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Has been a problem in the past but shouldn't be a problem if the oxygen level is maintained	
6	Medium	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	FAC is decreased with oxygen increase	
8	Low	High	High	Risk will be small if oxygenation specs met.	

Group **19** **Steam and Power Conversion System** **Feedwater**

Subgroup **19.2**

Valves
Carbon Steel - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
8,26,32,44,62,72,80
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed minor and within code allowable	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Fatigue loading assumed minor	

Subgroup **19.2**

Valves
Carbon Steel - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
8,26,32,44,62,72,80
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	High	High	Can be a problem during low temp. aerated layup	

Subgroup **19.2**

Valves
Carbon Steel - Base, Weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
8,26,32,44,62,72,80
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential SCC susceptibility at high potential	Oxygen content, water quality, cold work, residual stress
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Unlikely in this water.	Water purity
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Medium	Medium	High	Can be a problem if dynamic loading due to startup etc.	

Subgroup **19.3**

Weldolet
Carbon Steel - base, weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
39,77
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	FAC controlled by oxygen injection, otherwise potentially very vulnerable	Efficiency of oxygen injection equipment
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	Has been a problem in the past but shouldn't be a problem if the oxygen level is maintained	
6	Medium	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	Oxygen inhibits FAC. Flow in the small pipe seems low.	
8	Low	High	High	Risk will be small if oxygenation specs met.	

Group
19

Steam and Power Conversion System

Feedwater

Subgroup
19.3

Weldolet
Carbon Steel - base, weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
39,77
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Most sockolets have fatigue issues	
2	Low	High	High	Fatigue loading assumed minor and within code allowable	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	Medium	Medium	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Low	High	High	Fatigue loading assumed minor	
7	Medium	High	High	Fatigue failures of socket welds observed in field. Fatigue damage expected owing to robust large pipes and relatively flexible pipes attached by the socket welds.	
8	Low	Medium	High	Fatigue loading assumed minor	

Subgroup
19.3

Weldolet
Carbon Steel - base, weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
39,77
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	Flow and oxygen accelerate pitting.	
8	Medium	High	High	Can be a problem during low temp. aerated layup	

Subgroup **19.3**

Weldolet
Carbon Steel - base, weld and HAZ
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
39,77
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Potential SCC susceptibility at high potential	Oxygen content, water quality, cold work, residual stress
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Unlikely in this water.	Water purity
7	Medium	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. These are highly stressed and SCC and fatigue interact. Failures observed in field	
8	Medium	Medium	High	Can be a problem if dynamic loading due to startup etc.	

Subgroup **19.4**

Heater Pipes and Flow Elements
304 SS
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
49,102
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed minor and within code allowable	Cyclic loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	Pipe geometry might give some vibration.	
8	Low	Medium	High	Fatigue loading assumed minor	

Subgroup **19.4**

Heater Pipes and Flow Elements
304 SS
368-427F BWR water + >30 ppb O2 for FAC
HWC not relevant to most feedwater

Applies to BNL Part #s with prefix FW
49,102
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in absence of severe cold work	Cold work
3	Low	High	High		
4	Medium	High	High	High oxygen content	
5	Low	High	High	SC not likely for unsensitized stainless steel under these conditions	
6	Low	High	High	Unlikely in this water.	Water purity
7	Medium	Medium	Medium	This temperature range is the optimum for SCC of SS in the presence of oxygen	
8	Low	High	High		

Subgroup **20.1**

All Stainless Steel Components
External Surfaces When at <150°C
Normally Dry When at Low Temp
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
All
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Problem can develop fast with wet Cl	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	an issue only if alternate wet/dry or wet environments exist	
4	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.
5	Low	High	High	Well-known issue	Requires moisture and chloride, so is most likely during outages and layup
6	Low	High	High	Only possiblewhen wetted and Cl concentration	Wet condition and Cl concentration
7	Low	High	High	SCC occurs only when wetted and contaminants are present	
8	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

Subgroup **20.1**

All Stainless Steel Components
External Surfaces When at <150°C
Normally Dry When at Low Temp
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
All
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Problem can develop fast with wet Cl	
2	Low	High	High	Well known phenomenon. Cl from insulation and aerosols, the latter increasing with time, especially at marine sites	Concern only if wet. Tolerance for Cl depends on buffer availability from insulation.
3	Low	High	High	an issue only if alternate wet/dry or wet environments exist	
4	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.
5	Low	High	High	Well-known issue	Requires moisture and chloride, so is most likely during outages and layup
6	Low	High	High	Only possiblewhen wetted	Wet ccondition
7	Low	High	High	SCC occurs only when wetted and contaminants are present	
8	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)

Subgroup **20.2**

Pipes, Elbows, Tees and Wyes
SS Type 304
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
1,3,5,9,11,16,17,20,24,29,39,43,44,46,48,53,55
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loading assumed minor	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Fatigue less at lower temperatures. Not often observed in practice	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.2**

Pipes, Elbows, Tees and Wyes
SS Type 304
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
1,3,5,9,11,16,17,20,24,29,39,43,44,46,48,53,55

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	unlikely unless oxygen excursions occur	
4	Low	High	High	Low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. Not often observed in practice.	
8	Low	High	High	Unlikely at this temperature/deoxygenated/stress environment combination.	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.3**

308 SS Welds and HAZ
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
2,4,6,8,10,12,13,15,18,21,23,25,28,31,33,40,45,47,52,54
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loading assumed minor	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Fatigue less at lower temperatures. Not often observed in practice. 308 less than 304. Not often observed in practice in these temperature ranges.	
8	Low	Medium	High	Depends on degree of mechanical and thermal loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.3**

308 SS Welds and HAZ
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
2,4,6,8,10,12,13,15,18,21,23,25,28,31,33,40,45,47,52,54

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but not considered high at this low temperature	Residual welding stress, cold work, water quality, temperature
3	Low	High	High	unlikely unless oxygen excursions occur	
4	Low	High	High	Low temperature and good field experience	
5	Low	High	High	SCC of SS unlikely under these conditions -- HAZs are most susceptible	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. Not often observed in practice. 308 less intense than 304	
8	Medium	High	High	Possible at this temperature/deoxygenated/stress environment combination. However susceptibility score increased due to observed SCC associated with thermal stresses on introduction of coolant drive water	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.4**

Valves
Cast SS CF8
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
7,14,19,26,27,30,34,38,41,42,49,50,51
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loadings unlikely to be high	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	0	Medium	Medium	Minor cyclic stresses.	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.4**

Valves
Cast SS CF8
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
7,14,19,26,27,30,34,38,41,42,49,50,51
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC considered very low in duplex materials and at this low temperature	Stress, cold work, water quality, temperature. No thermal aging at this operating temperature
3	Low	High	High	unlikely unless oxygen excursions and high stresses occur	
4	Low	High	High	Good field experience and low temperature	
5	Low	Medium	Medium	SCC of stainless steels is unlikely under these conditions but data for cast materials are lacking	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	Minimal SCC at this temperature for SCC in deaerated solutions	
8	Low	High	Medium	Unlikely at this temperature/deoxygenated/stress environment combination. Know ledge score decreased due to relative lack of data, especially for aged material	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.5**

Flange
SS Type 316
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
22
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loadings unlikely to be high	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	0	Medium	Medium	Flange geometry is not prone to FAT	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.5**

Flange
SS Type 316
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
22
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	unlikely unless oxygen excursions and high stresses occur	
4	Low	High	High	Good field experience and low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	0	Medium	Medium	No SCC without oxygen and at this temperature	
8	Low	High	High	Unlikely at this temperature/deoxygenated/stress environment combination.	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.6**

Pump outlet Filter Shells
CS A 515, etc, unclad
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
32
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor and within code allowable	Cyclic loading
3	Low	High	High	fatigue loadings unlikely to be high	
4	Low	High	High		
5	Low	High	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	Medium	Medium	No clear geometry to intensify fatigue but this geometry may be complex and is next to a vibrational source	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.6**

Pump outlet Filter Shells
CS A 515, etc, unclad
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
32
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	temperatures too low for this to occur	
4	Low	High	High	Low oxygen content	
5	Low	High	High	SCC of carbon steel unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	0	Medium	Medium	No SCC without oxygen at this temperature	
8	Low	High	High	Unlikely for this alloy at this temperature/deoxygenated/stress environment combination.	

Subgroup **20.7**

Welds
Carbon Steel
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
57,58,59
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed minor and within code allowable	Cyclic loading
3	Low	High	High	fatigue loadings unlikely to be high	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	Medium	Medium	FAT is probably low but thermal cycling and mechanical cycling not know.	
8	Low	Medium	High	Depends on degree of mechanical loading	

Subgroup **20.7**

Welds
Carbon Steel
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
57,58,59
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	temperatures too low for this to occur	
4	Low	High	High		
5	Low	High	High	SCC of carbon steel unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC occurs in this range of temperatures but is less at minimal oxygen. Cold worked components in BWRs are stress relieved although magnitude of benefit not clear.	
8	Low	High	High	Unlikely for carbon steel at this temperature/deoxygenated/stress environment combination.	

Subgroup **20.8**

Valves
Cast SS CF8
Deoxygenated Reactor Water stagnant
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
35
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loadings unlikely to be high	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	0	Medium	Medium	The valves are robust and unlikely to sustain FAT	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.8**

Valves
Cast SS CF8
Deoxygenated Reactor Water stagnant
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
35
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC considered very low in duplex materials and at this low temperature	Stress, cold work, water quality, temperature. No thermal aging at this operating temperature
3	Low	High	High	temperatures too low for this to occur	
4	Low	High	High	Good field experience and low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	0	Medium	Medium	No basis for SCC here	
8	Low	High	Medium	Unlikely for duplex steels at this temperature/deoxygenated/stress environment combination. Knowledge score decreased due to relative lack of data, especially for aged material	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.9**

Welds SS 308
Deoxygenated Reactor Water stagnant
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
36
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loadings unlikely to be high	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	Medium	Medium	Low temperature, low oxygen but high cyclic stresses	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.9**

Welds SS 308
Deoxygenated Reactor Water stagnant
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
36
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC considered very low in duplex weld materials and at this low temperature	Stress, cold work, water quality, temperature.
3	Low	High	High	temperatures too low for this to occur	
4	Low	High	High	Good field experience and low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	0	Medium	Medium	Temperature low, oxygen low.	
8	Low	High	Medium	Unlikely for duplex steels at this temperature/deoxygenated/stress environment combination. Know ledge score decreased due to relative lack of data, especially for aged material	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.10**

Tee
SS Type 304
Deoxygenated Reactor Water stagnant
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
37
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	could be some fatigue loading	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Fatigue less at lower temperatures. Not often observed in practice	
8	Medium	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.10**

Tee
SS Type 304
Deoxygenated Reactor Water stagnant
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
37
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	temperatures too low for this to be a concern	
4	Low	High	High	Low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	High	High	SCC occurs at lower temperatures through about 100F when highly stressed and oxygen present. Not often observed in practice.	
8	Low	High	High	Unlikely for 304 stainless steel at this temperature/deoxygenated/stress environment combination.	

Subgroup **20.11**

Nozzles
Cast CS
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
56,60,61
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High	could be some fatigue loading	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	0	Medium	Medium	Nozzles are robust and not prone to FAT	
8	Low	Medium	High	Depends on degree of mechanical loading	

Group **20** **Auxiliary System** **Control Rod Drive**

Subgroup **20.11**

Nozzles
Cast CS
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
56,60,61
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC considered very low in duplex materials and at this low temperature	Stress, cold work, water quality, temperature. No thermal aging at this operating temperature
3	Low	High	High	temperatures too low for this to be a concern	
4	Low	High	High	Good field experience and low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	0	High	High	No SCC at this temperature in deaerated water	
8	Low	High	Medium	Unlikely for duplex steels at this temperature/deoxygenated/stress environment combination. Knowledge score decreased due to relative lack of data, especially for aged material	

Subgroup **20.12**

Pump Casing
Cast CS
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
62
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	fatigue loadings probably low	
4	Low	High	High		
5	Low	Medium	High	CUFs assumed to be small	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	Medium	Medium	Pump casing should be prone to FAT owing to the vibrational input of pump.	
8	Low	Medium	High	Depends on degree of mechanical loading	

Subgroup **20.12**

Pump Casing
Cast CS
Deoxygenated Reactor Water
107°F, 1275 psia
HWC not relevant to CRD drive water

Applies to BNL Part #s with prefix CRD
62
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC considered very low in duplex materials and at this low temperature	Stress, cold work, water quality, temperature. No thermal aging at this operating temperature
3	Low	High	High	temperatures too low for this to be a concern	
4	Low	High	High	Good field experience and low temperature	
5	Low	High	High	SCC of SS unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC possible but minimum in deaerated water	
8	Low	High	Medium	Unlikely for duplex steels at this temperature/deoxygenated/stress environment combination. Knowledge score decreased due to relative lack of data, especially for aged material	

Group **21** **Steam and Power Conversion System** **Main Condenser**

Subgroup **21.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports, shell
Carbon Steel - Base, Weld and HAZ
100-165°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
1-14,17-20,23-26,28-30

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Not likely to be significant	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	Some possibility for FAC owing to low oxygen and high velocities	
8	Medium	High	High	Possible in this temperature range	

Group
21

Steam and Power Conversion System

Main Condenser

Subgroup
21.1

Various plates, heads, pipes, baffles, manway, tube sheet, supports, shell
Carbon Steel - Base, Weld and HAZ
100-165°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
1-14,17-20,23-26,28-30
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Known problem	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	Some FAT is inevitable with high flows in condenser	
8	Low	Medium	High	Fatigue loading uncertain	

Subgroup **21.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports, shell
Carbon Steel - Base, Weld and HAZ
100-165°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
1-14,17-20,23-26,28-30
Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Very low with good quality water	Water quality
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Field experience has been OK	
6	Low	High	High		
7	Low	Medium	Medium	Low oxygen minimizes GC	
8	Medium	High	High	Possible in this temperature range	

Group **21** **Steam and Power Conversion System** **Main Condenser**

Subgroup **21.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports, shell
Carbon Steel - Base, Weld and HAZ
100-165°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
1-14,17-20,23-26,28-30

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Possible but probably very slow	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	Low oxygen minimizes PIT	
8	Medium	High	High	Possible in this temperature range	

Group **21** **Steam and Power Conversion System** **Main Condenser**

Subgroup **21.1**

Various plates, heads, pipes, baffles, manway, tube sheet, supports, shell
Carbon Steel - Base, Weld and HAZ
100-165°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
1-14,17-20,23-26,28-30

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but low in any case at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	High	High	SCC of C-steel unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	Low oxygen minimizes SCC	
8	Low	Medium	High	Not likely at this temperature range unless a very specific , unusual environment formed (nitrates, carbonate/bicarbonate, etc.)	

Subgroup **21.2**

Drainpipes
Carbon Steel - Base, Weld and HAZ
330-475°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
15-16,21-22

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Not likely to be significant	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	High velocities and low oxygen accelerates FAC	
8	Medium	High	High	Possible in this temperature range	

Subgroup **21.2**

Drainpipes
Carbon Steel - Base, Weld and HAZ
330-475°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
15-16,21-22
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	FAT low; loading and cyclic stressing not significant for FAT	
8	Low	Medium	High	Fatigue loading uncertain	

Group **21** **Steam and Power Conversion System** **Main Condenser**

Subgroup **21.2**

Drainpipes
Carbon Steel - Base, Weld and HAZ
330-475°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
15-16,21-22

Notes:

General Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Very low with good quality water	Water quality
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Field experience has been OK	
6	Low	High	High		
7	Low	Medium	Medium	GC is low since oxygen is low	
8	Medium	High	High	Possible in this temperature range	

Group **21** **Steam and Power Conversion System** **Main Condenser**

Subgroup **21.2**

Drainpipes
Carbon Steel - Base, Weld and HAZ
330-475°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
15-16,21-22
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	Medium	High	Possible but probably very slow	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	Pitting is low since oxygen is low	
8	Medium	High	High	Possible in this temperature range	

Subgroup **21.2**

Drainpipes
Carbon Steel - Base, Weld and HAZ
330-475°F BWR water
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
15-16,21-22

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Medium	High	High	Known problem	
5	Low	High	High	SCC of C-steel unlikely under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC significant in this range of temperature but oxygen is low	
8	Low	Medium	High	Not likely at this temperature range unless a very specific , unusual environment formed (nitrates, carbonate/bicarbonate, etc.)	

Subgroup **21.3**

Condenser Tubes (40,462 tubes), 1" OD and Baffle Plates
Stainless Steel, outside of tube
330-475°F BWR water on outside
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
27
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Known problem	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	FAT possible due to cross flow	
8	Medium	Medium	High	Fatigue loading uncertain,	

Subgroup **21.3**

Condenser Tubes (40,462 tubes), 1" OD and Baffle Plates
Stainless Steel, outside of tube
330-475°F BWR water on outside
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
27
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Pitting risk negligible in good quality water	Water quality
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Not likely to be significant	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	oxygen is low	
8	Low	High	High	Possible in this temperature range	

Group
21

Steam and Power Conversion System

Main Condenser

Subgroup
21.3

Condenser Tubes (40,462 tubes), 1" OD and Baffle Plates
Stainless Steel, outside of tube
330-475°F BWR water on outside
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
27
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	Field experience generally good	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC possible but oxygen is low and minimizes	
8	Low	Medium	High		

Subgroup **21.4**

Condenser Tubes (40,462 tubes), 1" OD
Stainless Steel, inside of tube
Circulating water (treated or sea/lake/pond)
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
27
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	FAT possible due to cross flow	
8	Medium	Medium	High	Fatigue loading uncertain	

Group
21

Steam and Power Conversion System

Main Condenser

Subgroup
21.4

Condenser Tubes (40,462 tubes), 1" OD
Stainless Steel, inside of tube
Circulating water (treated or sea/lake/pond)
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
27
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Pitting risk negligible in good quality water	Water quality
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	High	Not likely if guideline chemistry is maintained	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	Pitting occurs under fouling	
8	Medium	High	High	Possible in this temperature range especially if chlorides present	

Group **21** **Steam and Power Conversion System** **Main Condenser**

Subgroup **21.4**

Condenser Tubes (40,462 tubes), 1" OD
Stainless Steel, inside of tube
Circulating water (treated or sea/lake/pond)
HWC not relevant to condensate

Applies to BNL Part #s with prefix CONDNSR
27
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	Not likely unless chemistry transient occurs	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SS prone to SCC in sea water especially if concentrated or in crevices such as under fouling	
8	Medium	Medium	High	Very possible if chloride present	

Subgroup **21.5**

Condenser Tubes (other plants with Ti)
Titanium tubes, inside of tube (tubesheet other than Ti)
Sea water cooling

Applies to BNL Part #s with prefix CONDNSR
27

Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Erosion can be induced by high local velocities caused by flow restrictions due to fouling deposits	Fouling, water velocity
3	Medium	High	High	Ti tubing subject to EC if cooling water contaminated with abrasives, or if tubing flows increased by debris lodged in the tubes	
4	Medium	High	High	Known issue.	
5	Medium	High	High	Erosion can be induced by high local velocities caused by flow restruictions due to fouling deposits	Fouling, water velocity
6	Low	High	High	Less susceptible to EC in Ti Tubes	Velocity and droplets
7	Low	Medium	Medium	If flow path is narrowed and local velocities increased then EC can occur	
8	Medium	Medium	High	possible but very design specific	

Group
21

Steam and Power Conversion System

Main Condenser

Subgroup
21.5

Condenser Tubes (other plants with Ti)
Titanium tubes, inside of tube (tubesheet other than Ti)
Sea water cooling

Applies to BNL Part #s with prefix CONDNSR
27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	Cross flow may stimulate fatigue damage	
8	Medium	High	High	Fatigue loading uncertain	

Group
21

Steam and Power Conversion System

Main Condenser

Subgroup
21.5

Condenser Tubes (other plants with Ti)
Titanium tubes, inside of tube (tubesheet other than Ti)
Sea water cooling

Applies to BNL Part #s with prefix CONDNSR
27

Notes:

Galvanic Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Hydriding an issue when excessive cathodic protection applied in water box to protect non-Ti tube sheet	Cathodic protection potential
3	Medium	High	High	Ti tubes can be hydrided by over-protection from cathodic protection systems installed to protect tubesheet	
4	Low	Medium	High	Combination of non-titanium tube sheet and titanium tubes may result in galvanic corrosion if cathodic protection ineffective. This can in turn lead to hydriding of the titanium tubes.	
5	Medium	High	High	Hydriding will be an issue if excessive cathodic protection is applied in water box to protect non-Ti tube sheet	Cathodic protection potential
6	Medium	High	High	Field experiences of GALV and also hydride formation due to over cathodic protection	
7	Low	Medium	Medium	Possible problem if cathodic protection	
8	Medium	Medium	High	possible if connected to carbon steel tubesheet, very design specific	

Group
21

Steam and Power Conversion System

Main Condenser

Subgroup
21.5

Condenser Tubes (other plants with Ti)
Titanium tubes, inside of tube (tubesheet other than Ti)
Sea water cooling

Applies to BNL Part #s with prefix CONDNSR
27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Concern for hydriding	
2	Low	High	High	Possible concern for hydriding	
3	Low	High	High	Concern for hydriding	
4	Low	High	High	Concern for hydriding	
5	Low	Medium	High	Generally good field experience	
6	Low	High	High	Concern for hydriding	
7	0	High	High	Ti resists sea water corrosion	
8	Low	High	High	Concern for hydriding especially if tube sheets cathodicaly protected	

Subgroup **21.6**

Condenser Tubes (other plants with Ti)
Titanium tubes, outside of tube
Wet steam

Applies to BNL Part #s with prefix CONDNSR
27

Notes:

Erosion Corrosion Including Steam Cutting and Cavitation

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Droplet erosion a known issue, design dependent	Droplet velocity
3	High	High	High	Ti condenser tubes susceptible to wet steam EC in inlet areas of condensers; baffle plates or use of SS tubing in outer (steam inlet) areas of condenser are the solution.	
4	Medium	High	High	Known issue	
5	Medium	High	High	Droplet erosion a known issue, design dependent	Droplet velocity
6	Low	High	High	Less susceptible to EC in Ti Tubes	Velocity and droplets
7	Medium	Medium	Medium	If the Ti is exposed directly to incoming steam perforation occurs. This usually handled by using outside stainless steel tubes.	
8	Medium	Medium	High	possible but very design specific	

Subgroup **22.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA106,A234,A672,SA216 - Carbon steels - base, weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
1-4,6-22,25-28,30,31,33,35-44,46,47,50-53

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assume oxygen is sufficient to suppress significant FAC	Velocity, oxygen content
3	0	High	High	FAC will not occur under these conditions	
4	Low	High	High		
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	Oxygenation minimizes FAC	
8	Medium	High	High	Possible in this temperature range	

Group **22** **Steam and Power Conversion System** **Main Condenser Discharge Piping**

Subgroup **22.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA106,A234,A672,SA216 - Carbon steels - base, weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
1-4,6-22,25-28,30,31,33,35-44,46,47,50-53

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	Continuous operation, high flows, vibration	
8	Low	Medium	High	Fatigue loading uncertain	

Subgroup **22.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA106,A234,A672,SA216 - Carbon steels - base, weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
1-4,6-22,25-28,30,31,33,35-44,46,47,50-53

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Medium	High	High	pitting can occur in low flow/stagnant areas	
4	Medium	High	High	High oxygen content	
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	oxygenated water	
8	Medium	High	High	Possible in this temperature range and higher oxygen	

Subgroup **22.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA106,A234,A672,SA216 - Carbon steels - base, weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
1-4,6-22,25-28,30,31,33,35-44,46,47,50-53

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	High stresses, oxygen, SCC prone material	
8	Low	Medium	High	Unlikely in this temperature range	

Subgroup **22.2**

Weldolet
A234 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
5,29
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assume oxygen is sufficient to suppress significant FAC	Velocity, oxygen content
3	0	High	High	FAC will not occur under these conditions	
4	Low	High	High	Mitigation measure in place	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	oxygenated water minimizes FAC	
8	Medium	High	High	Possible in this temperature range	

Subgroup **22.2**

Weldolet
A234 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
5,29
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Most sockolets have fatigue issues	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	High	High	Fatigue loading is significant	
7	Medium	Medium	Medium	These geometries have high leverage for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Medium	Medium	High	Fatigue loading uncertain, but must be assumed to occur in these designs	

Subgroup **22.2**

Weldolet
A234 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
5,29
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Medium	High	High	pitting can occur in low flow/stagnant conditions	
4	Medium	High	High	High oxygen content	
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	oxygenated water	
8	Medium	High	High	Possible in this temperature range and higher oxygen	

Subgroup **22.2**

Weldolet
A234 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
5,29
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Unlikely in this temperature range	

Subgroup **22.3**

Valves
A105,A216 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
23,24,34
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assume oxygen is sufficient to suppress significant FAC	Velocity, oxygen content
3	0	High	High	FAC will not occur under these conditions	
4	Low	High	High	Mitigation measure in place	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	oxygenated water minimizes FAC	
8	Medium	High	High	Possible in this temperature range	

Subgroup **22.3**

Valves
A105,A216 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
23,24,34
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	High	High	The valves do not appear especially prone to large cyclic loading.	
8	Low	Medium	High	Fatigue loading uncertain	

Subgroup **22.3**

Valves
A105,A216 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
23,24,34
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Medium	High	High	pitting can occur in low flow/stagnant conditions	
4	Medium	High	High	High oxygen content	
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	Pitting is certain owing to deposits, quality, oxygen	
8	Medium	High	High	Possible in this temperature range and higher oxygen	

Subgroup **22.3**

Valves
A105,A216 Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
23,24,34

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Unlikely in this temperature range	

Subgroup **22.4**

Pump
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
45
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assume oxygen is sufficient to suppress significant FAC	Velocity, oxygen content
3	0	High	High	FAC will not occur under these conditions	
4	Low	High	High	Mitigation measure in place	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC is somewhat minimized by presence of oxygen. However, surface velocities are high.	
8	Medium	High	High	Possible in this temperature range	

Subgroup **22.4**

Pump
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
45

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Medium	Medium	Medium	Pump produces high frequency vibration plus harmonics. FAC may be accelerated with presence of SCC	
8	Low	Medium	High	Fatigue loading uncertain	

Subgroup **22.4**

Pump
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
45
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Medium	High	High	pitting can occur in low flow/stagnant conditions	
4	Medium	High	High	High oxygen content	
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	Presence of oxygen accerates pitting	
8	Medium	High	High	Possible in this temperature range	

Subgroup **22.4**

Pump
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
45
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	This temperature range and presence of oxygen together with cold worked components accelerate SCC	
8	Low	Medium	High	Unlikely in this temperature range	

Subgroup **22.5**

Ejector Body & Nozzle
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
32
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Assume oxygen is sufficient to suppress significant FAC	Velocity, oxygen content
3	0	High	High	FAC will not occur under these conditions	
4	Low	High	High	Mitigation measure in place	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC is somewhat minimized by presence of oxygen. However, surface velocities are high.	
8	Medium	High	High	Possible in this temperature range	

Subgroup **22.5**

Ejector Body & Nozzle
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
32
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	High fluid velocities produces vibrations and harmonics. Presence of oxygen increases pitting and SCC that in turn accelerate FAC.	
8	Low	Medium	High	Fatigue loading uncertain	

Subgroup **22.5**

Ejector Body & Nozzle
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
32
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of pitting at inclusions	Water quality
3	Medium	High	High	pitting can occur in low flow/stagnant conditions	
4	Medium	High	High	High oxygen content	
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Medium	Medium	Medium	Pitting accelerated by oxygen	
8	Medium	High	High	Possible in this temperature range and higher oxygen	

Subgroup **22.5**

Ejector Body & Nozzle
Carbon Steel - Base, Weld and HAZ
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
32
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC possible in this range of oxygen and temperature. SCC accelerated by cold work and residual stress	
8	Low	Medium	High	Unlikely in this temperature range	

Subgroup **22.6**

Flow Restrictor
Stainless Steel
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
48,49

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	High fluid velocities and differential velocities. Harmonics at lower frequencies.	
8	Low	Medium	High	Fatigue loading uncertain	

Subgroup **22.6**

Flow Restrictor
Stainless Steel
121°F BWR water, >>30 ppb O2
HWC not relevant here

Applies to BNL Part #s with prefix CONDISCH
48,49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for SS under these conditions	
6	Low	High	High		
7	Low	Medium	Medium	SCC possible in low range of temperature plus oxygen	
8	Medium	Medium	High	Unlikely in this temperature range, unless O2 in range 100-200ppb	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pump**

Subgroup **23.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
1-6,8-10,12-25,27,29-31,33-47,49-57

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	Low oxygen promotes FAC if velocities high in this temperature range	
8	Medium	High	High	Possible in this temperature range especially if oxygen low but uncontrolled	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pumps**

Subgroup **23.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
1-6,8-10,12-25,27,29-31,33-47,49-57

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	Low oxygen minimizes initiation and growth rate	
8	Low	Medium	High	Fatigue loading uncertain	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pumps**

Subgroup **23.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
1-6,8-10,12-25,27,29-31,33-47,49-57
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	Low oxygen lowers pitting rate	
8	Low	High	High	Unlikely in this temperature and low O2 range	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pump**

Subgroup **23.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - Base, Weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
1-6,8-10,12-25,27,29-31,33-47,49-57
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	low oxygen minimizes SCC in this range of temperatures	
8	Low	Medium	High	Unlikely in this temperature and low O2 range	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pumps**

Subgroup **23.2**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
11,26,32
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	No significant flow in small pipe	
8	Medium	High	High	Possible in this temperature range especially if oxygen low but uncontrolled	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pumps**

Subgroup **23.2**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
11,26,32
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	Most sockolets have fatigue issues, but fatigue loading here (124F) may be minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Low	High	High	Fatigue loading is of concern	Small amplitude and high cycle
7	Medium	Medium	High	These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. Low oxygen lowers initiation of FAT	
8	Medium	Medium	High	Fatigue loading probable for this design	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pump**

Subgroup **23.2**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
11,26,32
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	Low pitting rate in low oxygen	
8	Low	High	High	Unlikely in this temperature and low O2 range	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pump**

Subgroup **23.2**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
11,26,32
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Minimized by low oxygen	
8	Low	Medium	High	Unlikely in this temperature and low O2 range	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pump**

Subgroup **23.3**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
7,28,48
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Low	Medium	Medium	Possible acceleration owing to low oxygen	
8	Medium	High	High	Possible in this temperature range especially if oxygen low but uncontrolled	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pumps**

Subgroup **23.3**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
7,28,48
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	Small amplitude and high cycle
7	Medium	Medium	High	Low oxygen lowers initiation of FAT. Cold work accelerates	
8	Low	Medium	High	Fatigue loading uncertain	

Group
23

Steam and Power Conversion System

Condensate Piping to Booster Pump

Subgroup
23.3

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
7,28,48
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	Low pitting rate in low oxygen	
8	Low	High	High	Unlikely in this temperature and low O2 range	

Group **23** **Steam and Power Conversion System** **Condensate Piping to Booster Pumps**

Subgroup **23.3**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDBPMP
7,28,48
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Minimized by low oxygen	
8	Low	Medium	High	Unlikely in this temperature and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124°F BWR water (probably low O2)

Applies to BNL Part #s with prefix CONDFWPMP
1-6,8,10-25,27

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC accentuated with low oxygen	
8	Medium	High	High	Possible in this temperature range especially if oxygen low but uncontrolled	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124°F BWR water (probably low O2)

Applies to BNL Part #s with prefix CONDFWPMP
1-6,8,10-25,27
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	Medium	High	Fatigue loading uncertain	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124°F BWR water (probably low O2)

Applies to BNL Part #s with prefix CONDFWPMP
1-6,8,10-25,27
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	without oxygen pitting is low	
8	Low	High	High	Unlikely in this temperature and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.1**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124°F BWR water (probably low O2)

Applies to BNL Part #s with prefix CONDFWPMP
1-6,8,10-25,27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in 100F range but slowly. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	Unlikely in this temperature and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.2**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
28-32,34-39,51-43,45-51,53-56,59-61,63-65

Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC accentuated with low oxygen	
8	Medium	High	High	Possible in this temperature range especially at lower temperature if oxygen low but uncontrolled	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.2**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
28-32,34-39,51-43,45-51,53-56,59-61,63-65

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses	
8	Low	Medium	High	Fatigue loading uncertain	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.2**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
28-32,34-39,51-43,45-51,53-56,59-61,63-65

Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	without oxygen pitting is low	
8	Low	High	High	Unlikely in this temperature range and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.2**

Various pipes, elbows, reducers, tees, flanges, nozzles, wye, etc.
SA105,A106,SA216,A234,A672 - Carbon steels - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
28-32,34-39,51-43,45-51,53-56,59-61,63-65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in this range of temperatures and increases with the increasing temperature. With the low oxygen, SCC will be minimal but accentuated by cold work and welds	
8	Low	Medium	High	Unlikely in this temperature range and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.3**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
11,26,32
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC accentuated with low oxygen	
8	Medium	High	High	Possible in this temperature range especially at lower temperature if oxygen low but uncontrolled	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pumps**

Subgroup **24.3**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
11,26,32
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Many sockolets have fatigue issues	
2	Medium	High	High	Socket weld fatigue issue	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	High	High	Well known fatigue issue	Small amplitude and high cycle
7	Medium	Medium	Medium	Fatigue is accentuated by the small tube attached to the large base. Large lever arm. Fatigue observed in field.	
8	Medium	Medium	High	Fatigue loading likely to be higher in this design	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.3**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
11,26,32
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	without oxygen pitting is low	
8	Low	High	High	Unlikely in this temperature range and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.3**

Sockolet
SA106,SA216,A234,A672 carbon steel - base, weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
11,26,32
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in this range of temperatures and increases with the increasing temperature. With the low oxygen, SCC will be minimal but accentuated by cold work and welds	
8	Low	Medium	High	Unlikely in this temperature range and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.4**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC accentuated with low oxygen	
8	Medium	High	High	Possible in this temperature range especially if oxygen low but uncontrolled	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.4**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is of concern	Small amplitude and high cycle
7	Low	High	High	Valves are generally robust construction but may have features that intensify stress.	
8	Low	Medium	High	Fatigue loading uncertain	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.4**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	without oxygen pitting is low	
8	Low	High	High	Unlikely in this temperature range and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.4**

Valves
SA105,SA216,A672 carbon steel - base, weld and HAZ
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in this range of temperatures and increases with the increasing temperature. With the low oxygen, SCC will be minimal but accentuated by cold work and welds	
8	Low	Medium	High	Unlikely in this temperature range and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.5**

Pump
Carbon Steel - Base, Weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Flow-Assisted Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	FAC could be significant if completely de-oxygenated	Velocity, oxygen content
3	Low	High	High	high flows and very low oxygen needed	
4	Medium	High	High	Depending on flow rates and material composition	
5	Low	Medium	High	Worth doing the analysis but flow rates are not particularly high	
6	Low	High	High	Potential dengaradation mode in CS	Local flow velocity
7	Medium	Medium	Medium	FAC accentuated with low oxygen	
8	Medium	High	High	Possible in this temperature especially if oxygen low but uncontrolled	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.5**

Pump
Carbon Steel - Base, Weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is of concern	Small amplitude and high cycle
7	Medium	High	High	High cyclic frequency but with harmonics. Also, startups and shutdowns. Low oxygen minimizes initiation due to SCC and pits.	
8	Medium	Medium	High	Fatigue loading uncertain, but likely to be higher in this component	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.5**

Pump
Carbon Steel - Base, Weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Pitting Corrosion

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Some risk of minor pitting at inclusions even in absence of oxygen	Water quality
3	Low	High	High	pitting occurs if oxygen excursions can occur	
4	Low	High	High		
5	Low	Medium	High	Possible but probably slow under these conditions	
6	Low	High	High	Cl may cause pitting	Water purity
7	Low	Medium	Medium	without oxygen pitting is low	
8	Low	High	High	Unlikely in this temperature and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pumps**

Subgroup **24.5**

Pump
Carbon Steel - Base, Weld and HAZ
365°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
7,9,26,,33,44,52
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of carbon steel can occur in this range of temperatures and increases with the increasing temperature. With the low oxygen, SCC will be minimal but accentuated by cold work and welds	
8	Low	Medium	High	Unlikely at this temperature and low O2 range	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pumps**

Subgroup **24.6**

Heater Tubes
304 SS
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
62

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but very low in any case at this low temperature	Stress, cold work, water quality, temperature
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Fatigue loading assumed minor	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	FAT may be accentuated by cross flow	
8	Low	High	High	Fatigue loading assumed minor	

Group **24** **Steam and Power Conversion System** **Condensate Piping to FW Pump**

Subgroup **24.6**

Heater Tubes
304 SS
124-370°F BWR water (probably low O2)
HWC not relevant here

Applies to BNL Part #s with prefix CONDFWPMP
62
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for heater tubes under these conditions	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	High	High	Higher end of this range is rapid SCC. Low oxygen reduces the SCC	
8	Low	High	High	Possible but unlikely in a O2 environment. Source of stress uncertain	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.1**

Various elbows, reducers and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain. Specific characteristics will determine environmental degradation	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.1**

Various elbows, reducers and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.1**

Various elbows, reducers and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.1**

Various elbows, reducers and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.2**

Welds and HAZ in various elbows, reducers and pipe
SA105,106,216,234 - Carbon Steel Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain. Specific characteristics will determine environmental degradation	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.2**

Welds and HAZ in various elbows, reducers and pipe
SA105,106,216,234 - Carbon Steel Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including welds, bending and flow; low oxygen with reduced initiation due to pitting and SCC	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.2**

Welds and HAZ in various elbows, reducers and pipe
SA105,106,216,234 - Carbon Steel Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication and other residual sources, high oxygen, high temperature	
8	Medium	High	High	Susceptibility will be low unless there is a superimposed dynamic loading	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.2**

Welds and HAZ in various elbows, reducers and pipe
SA105,106,216,234 - Carbon Steel Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
13-20,23-27,29-30,33-37,40-46,49-60

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication, welding and other residual sources, low oxygen, high temperature	
8	Low	High	High	HWC will improve resistance	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.3**

Various elbows, reducers and pipe (base metal)
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **25** **Support System**

Reactor Water Cleanup Piping to Pumps

Subgroup **25.3**

Various elbows, reducers and pipe (base metal)
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.3**

Various elbows, reducers and pipe (base metal)
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC in oxidizing conditions, depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High	Generic problem.	C content and cold work aggravating factors.
5	Low	High	High	Base metal is not very susceptible	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication and other residual sources, high oxygen, high temperature	
8	Low	High	High	Unknown source of sustained tensile stress in base material	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.3**

Various elbows, reducers and pipe (base metal)
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High	Generic problem.	C content and cold work aggravating factors.
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High		

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.4**

Various elbows, reducers and pipe (weld metal)
304 Stainless Steel - Weld Metal
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.4**

Various elbows, reducers and pipe (weld metal)
304 Stainless Steel - Weld Metal
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.4**

Various elbows, reducers and pipe (weld metal)
304 Stainless Steel - Weld Metal
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated. Small effect only of thermal aging on toughness of weld metal given relatively low ferrite content.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.4**

Various elbows, reducers and pipe (weld metal)
304 Stainless Steel - Weld Metal
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High	Generic problem.	C content and cold work aggravating factors.
5	Low	High	High	Weld metal is not very susceptible	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low in duplex morphology	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.4**

Various elbows, reducers and pipe (weld metal)
304 Stainless Steel - Weld Metal
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High	Generic problem.	C content and cold work aggravating factors.
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.5**

Various elbows, reducers and pipe (HAZ)
304 Stainless Steel - HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.5**

Various elbows, reducers and pipe (HAZ)
304 Stainless Steel - HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Medium	High	High		
4	Medium	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.5**

Various elbows, reducers and pipe (HAZ)
304 Stainless Steel - HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High		
4	Medium	Medium	Medium	Insufficient data, but lab indications could be a problem.	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.5**

Various elbows, reducers and pipe (HAZ)
304 Stainless Steel - HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	High	High	High	Risk of SCC in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High		
4	Medium	High	High	Generic problem.	C content and cold work aggravating factors.
5	Medium	High	High	HAZs are susceptible to SCC	
6	Medium	Medium	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	High	High	High	Well known cracking system	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.5**

Various elbows, reducers and pipe (HAZ)
304 Stainless Steel - HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
4-5,9-11

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Medium	High	High	Generic problem.	C content and cold work aggravating factors.
5	Low	High	High	HWC benefit expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.6** Weldolets and Sockolets
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
38-39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	All sockolets may have fatigue issues	
2	Medium	High	High	Fatigue of sockolet known issue. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Medium	High	High		
4	Medium	High	High	Generic problem.	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	Medium	Medium	Well known issue	Prediction model developed
7	Medium	Medium	Medium	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Medium	Medium	High	Fatigue loading uncertain but likely to be high in this design. Specific characteristics will determine environmental degradation	

Group **25** **Support System**

Reactor Water Cleanup Piping to Pumps

Subgroup **25.6**

Weldolets and Sockolets
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
38-39

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	All sockolets may have fatigue issues	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Medium	High	High	Generic problem.	
5	Medium	High	Medium	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. Low oxygen reduces the initiation by pit or CF	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **25** **Support System**

Reactor Water Cleanup Piping to Pumps

Subgroup **25.6**

Weldolets and Sockolets
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
38-39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs especially at welded and heavily cold worked regions. Accelerated by dissolved oxygen	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress and lack of sustainable cracking in this alloy class	

Group **25** **Support System**

Reactor Water Cleanup Piping to Pumps

Subgroup **25.6**

Weldolets and Sockolets
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
38-39

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Low oxygen reduces SCC.	
8	Low	High	High	Susceptibility will be lowered by HWC	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.7**

Weldolets and Sockolets
304 Stainless Steel - Base, Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
1-3,6-8

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	All sockolets may have fatigue issues	
2	Medium	High	High	Fatigue of sockolet known issue	Fatigue loading
3	Medium	High	High		
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	Medium	Medium	Well known issue	Prediction model developed
7	Medium	Medium	Medium	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Medium	Medium	High	Fatigue loading uncertain but will likely be high in this design; specific environmental effect will depend on the loading specifics	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.7**

Weldolets and Sockolets
304 Stainless Steel - Base, Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
1-3,6-8

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	All sockolets may have fatigue issues	
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. Lower oxygen reduces pitting and SCC and mitigates fat	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.7**

Weldolets and Sockolets
304 Stainless Steel - Base, Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
1-3,6-8

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High		
4	Medium	Medium	Medium	Insufficient data, but lab indications could be a problem.	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.7**

Weldolets and Sockolets
304 Stainless Steel - Base, Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
1-3,6-8

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High	Fatigue usually dominates over SCC	
2	High	High	High	Risk of SCC of HAZs in oxidizing conditions, depends on level of sensitization, cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Medium	High	High		
4	Medium	High	High	Generic problem	C content and cold work aggravating
5	Medium	High	High	HAZs are susceptible to SCC	
6	Medium	Medium	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	High	High	SCC of stainless steel can occur in 535F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Accelerated by oxygen.	
8	High	High	High	Well known cracking system for HAZ	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.7**

Weldolets and Sockolets
304 Stainless Steel - Base, Weld & HAZ
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
1-3,6-8

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work in HAZ and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High	Generic problem	C content and cold work aggravating
5	Low	High	High	HWC benefit expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of stainless steel can occur in 535F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Mitigated by low oxygen	
8	Low	High	High	Susceptibility will be lowered by HWC	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.8**

Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
12,21-22,28,31-32,47-48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Valves are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **25** **Support System**

Reactor Water Cleanup Piping to Pumps

Subgroup **25.8**

Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
12,21-22,28,31-32,47-48

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **25** **Support System**

Reactor Water Cleanup Piping to Pumps

Subgroup **25.8**

Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
12,21-22,28,31-32,47-48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	Medium	Medium	SCC of carbon steel occurs in 535F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress and lack of sustainable cracking in this alloy class	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.8**

Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
12,21-22,28,31-32,47-48

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel occurs in 535F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be lowered by HWC	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.9**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
61-65

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Pump arts assumed to be subjected to oscillating stresses to produce fatigue damage	
8	Medium	Medium	High	Fatigue loading uncertain but will likely be high in this design . Specific characteristics will determine environmental degradation	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.9**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
61-65

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	Medium	Medium	Fatigue damage reduced with low oxygen which lowers SCC and pitting initiation.	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.9**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
61-65

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions when exposed to dissolved oxygen.	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress and lack of sustainable cracking in this alloy class	

Group **25** **Support System** **Reactor Water Cleanup Piping to Pumps**

Subgroup **25.9**

HPCS Pump Parts
A106,A516 Carbon & Low Alloy Steels
535°F BWR water

Applies to BNL Part #s with prefix RWCUPMPS
61-65

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions. SCC is minimized by low oxygen	
8	Low	High	High	Susceptibility will be lowered by HWC	

Subgroup **26.1**

Various elbows, flanges and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain. Specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.1**

Various elbows, flanges and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.1**

Various elbows, flanges and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.1**

Various elbows, flanges and pipe (base metal)
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.2**

Welds and HAZ in various elbows, flanges and pipe
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain. Specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.2**

Welds and HAZ in various elbows, flanges and pipe
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including welds, bending and flow; low oxygen with reduced initiation due to pitting and SCC	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.2**

Welds and HAZ in various elbows, flanges and pipe
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication and other residual sources, high oxygen, high temperature	
8	Medium	High	High	Susceptibility will be low unless there is a superimposed dynamic loading	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.2**

Welds and HAZ in various elbows, flanges and pipe
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
1-5,9-10,14,18-19,22-25

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication, welding and other residual sources, low oxygen, high temperature	
8	Low	High	High	HWC will improve resistance	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.3**

Sockolet - base, weld and HAZ
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
6-8

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	All sockolets may have fatigue issues	
2	Medium	High	High	Fatigue of sockolet known issue. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Medium	High	High		
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	High	High	Well known issue	Prediction model developed
7	Medium	Medium	Medium	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Medium	Medium	High	Fatigue loading uncertain but likely to be high in this design. Specific characteristics will determine environmental degradation	

Subgroup **26.3**

Sockolet - base, weld and HAZ
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
6-8

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	All sockolets may have fatigue issues	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Generic problem	
5	Medium	High	Medium	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. Low oxygen reduces the initiation by pit or CF	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Subgroup **26.3**

Sockolet - base, weld and HAZ
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
6-8

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	Medium	Medium	SCC occurs especially at welded and heavily cold worked regions. Accelerated by dissolved oxygen	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress and lack of sustainable cracking in this alloy class	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.3**

Sockolet - base, weld and HAZ
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
6-8

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Low oxygen reduces SCC.	
8	Low	High	High	Susceptibility will be lowered by HWC	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.4**

Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
10-13,15-17,20-21

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Valves are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.4** Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
10-13,15-17,20-21

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.4** Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
10-13,15-17,20-21

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	Medium	Medium	SCC of carbon steel occurs in 535F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be low , due to uncertain source of sufficient tensile stress and lack of sustainable cracking in this alloy class	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.4** Valves
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
10-13,15-17,20-21

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel occurs in 535F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be lowered by HWC	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.5**

HX Nozzle
SA105,106,216,234 - Carbon Steel
435-535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.5**

HX Nozzle
SA105,106,216,234 - Carbon Steel
435-535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
26

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High		
4	Medium	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.5**

HX Nozzle
SA105,106,216,234 - Carbon Steel
435-535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	Medium	Medium	SCC of carbon steel occurs in 435-535F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Medium	Medium	High	Susceptibility will be higher at the lower temperature range . However lower confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.5**

HX Nozzle
SA105,106,216,234 - Carbon Steel
435-535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
26

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel occurs in 535F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be lowered by HWC	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.6**

HX Nozzle
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
35

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.6**

HX Nozzle
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
35

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.6**

HX Nozzle
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
35

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated. Small effect only of thermal aging on toughness of weld metal given relatively low ferrite content.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.6**

HX Nozzle
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
35

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses, degree of sensitization of HAZs and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for annealed SS under these conditions	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	Medium	Medium	SCC of carbon steel occurs in 535F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be low in the duplex welds	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.6**

HX Nozzle
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
35

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel occurs in 535F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Susceptibility will be lowered even further	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.7**

Regenerative heat exchanger head and shell
304 stainless steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
33-34

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.7**

Regenerative heat exchanger head and shell
304 stainless steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
33-34

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.7**

Regenerative heat exchanger head and shell
304 stainless steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
33-34

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated. Small effect only of thermal aging on toughness of weld metal given relatively low ferrite content.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.7**

Regenerative heat exchanger head and shell
304 stainless steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
33-34

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses, degree of sensitization of HAZs and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for annealed SS under these conditions	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low in the duplex welds	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.7**

Regenerative heat exchanger head and shell
304 stainless steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
33-34

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.8**

Regenerative heat exchanger tubesheet
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
36

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Known problem with HX internals	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.8**

Regenerative heat exchanger tubesheet
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
36

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Medium	High	High	Known problem with HX internals	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.8**

Regenerative heat exchanger tubesheet
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
36

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated. Small effect only of thermal aging on toughness of weld metal given relatively low ferrite content.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.8**

Regenerative heat exchanger tubesheet
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
36

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses, degree of sensitization of HAZs and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for annealed SS under these conditions	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low in the duplex welds	

Group **26** **Support System**

Reactor Water Cleanup Piping to R/NR HXs

Subgroup **26.8**

Regenerative heat exchanger tubesheet
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
36

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.9**

Regenerative heat exchanger tubes
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
37

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.9**

Regenerative heat exchanger tubes
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
37

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Subgroup **26.9**

Regenerative heat exchanger tubes
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
37

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated. Small effect only of thermal aging on toughness of weld metal given relatively low ferrite content.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.9**

Regenerative heat exchanger tubes
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
37

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for annealed SS under these conditions	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low in the duplex welds	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.9**

Regenerative heat exchanger tubes
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
37

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses, degree of sensitization of HAZs and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Subgroup **26.10**

Regenerative heat exchanger baffles
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
38,40

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Known problem with HX internals	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.10**

Regenerative heat exchanger baffles
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
38,40

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Medium	High	High	Known problem with HX internals	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.10**

Regenerative heat exchanger baffles
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
38,40

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Group **26** **Support System**

Reactor Water Cleanup Piping to R/NR HXs

Subgroup **26.10**

Regenerative heat exchanger baffles
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
38,40

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely under these conditions	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low in the duplex welds	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.10**

Regenerative heat exchanger baffles
304 Stainless Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
38,40

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.11** Non-regenerative heat exchanger baffles and fittings
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
47

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	Medium	Known problem with HX internals	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Baffles assumed to be subjected to oscillating stresses to produce fatigue damage	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.11**

Non-regenerative heat exchanger baffles and fittings
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
47

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Medium	High	High	Known problem with HX internals	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	High	High	Fatigue damage reduced with low oxygen which lowers SCC and pitting initiation.	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Subgroup **26.11**

Non-regenerative heat exchanger baffles and fittings
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
47

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	High	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions when exposed to dissolved oxygen.	
8	Low	Medium	High	lower confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.11** Non-regenerative heat exchanger baffles and fittings
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
47

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions. SCC is minimized by low oxygen	
8	Low	High	High	Susceptibility will be lowered further by HWC	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.12**

Regenerative heat exchanger internal piping
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
39

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain; specific environmental effect will depend on the loading specifics	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HXs**

Subgroup **26.12**

Regenerative heat exchanger internal piping
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
39

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Fatigue loading assumed to be within code allowable. Possible effect of HWC on corrosion fatigue for low frequency loading	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; low oxygen	
8	Medium	Medium	High	Susceptibility may be increased depending on specific loading conditions	

Group **26** **Support System**

Reactor Water Cleanup Piping to R/NR HXs

Subgroup **26.12**

Regenerative heat exchanger internal piping
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
39

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated. Small effect only of thermal aging on toughness of weld metal given relatively low ferrite content.	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Also, the low toughness seems to be more of a low temperature phenomenon. Temperature range not well defined.	
8	Low	Medium	Medium	Uncertainty of effect of environment on fracture toughness measurement	

Subgroup **26.12**

Regenerative heat exchanger internal piping
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
39

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Low risk of SCC in oxidizing conditions, depends on residual stresses, degree of sensitization of HAZs and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for annealed SS under these conditions	
6	Low	High	Medium	SCC in SS with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	High stresses due to fabrication, welding and other residual sources, high oxygen, high temperature	
8	Low	High	High	Susceptibility will be low in the duplex welds	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.12**

Regenerative heat exchanger internal piping
304 Stainless Steel (assume welds annealed)
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
39

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but depends on level of cold work and water quality	Stress, metallurgical condition, water quality, oxidation potential
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, low oxygen, high temperature	
8	Low	High	High	Susceptibility will be lowered even further	

Subgroup **26.13**

Non-regenerative heat exchanger internal piping
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	Medium	Medium	Piping assumed to be subjected to oscillating stresses to produce fatigue damage	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Subgroup **26.13**

Non-regenerative heat exchanger internal piping
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
48

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	High	High	Fatigue damage reduced with low oxygen which lowers SCC and pitting initiation.	
8	Low	Medium	High	Fatigue loading uncertain. HWC will be beneficial but specific characteristics will determine environmental degradation	

Group **26** **Support System**

Reactor Water Cleanup Piping to R/NR HX

Subgroup **26.13**

Non-regenerative heat exchanger internal piping
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for these materials under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions when exposed to dissolved oxygen.	
8	Low	Medium	High	lower confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class	

Subgroup **26.13**

Non-regenerative heat exchanger internal piping
SA105,106,216,234 - Carbon Steel
535°F BWR water

Applies to BNL Part #s with prefix RWCUHX
48

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions. SCC is minimized by low oxygen	
8	Low	High	High	Susceptibility will be lowered further by HWC	

Group **26** **Support System** **Reactor Water Cleanup Piping to R/NR HX**

Subgroup **26.14**

Various components in lower temp water
SA105,106,216,234 - Carbon Steel
120-235°F BWR water. No HWC benefit here.

Applies to BNL Part #s with prefix RWCUHX
28-30,31-32,44,47,48

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Medium	High	High	Piping assumed to be subjected to oscillating stresses to produce fatigue damage	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **26** **Support System**

Reactor Water Cleanup Piping to R/NR HX

Subgroup **26.14**

Various components in lower temp water
SA105,106,216,234 - Carbon Steel
120-235°F BWR water. No HWC benefit here.

Applies to BNL Part #s with prefix RWCUHX
28-30,31-32,44,47,48

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for these materials under these conditions	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel can occur in 535F range. SCC occurs especially at welded and heavily cold worked regions when exposed to dissolved oxygen.	
8	Low	Medium	High	low confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class especially in this low temperature range	

Subgroup **26.15**

Various components in lower temp water
304 Stainless Steel (welds assume annealed)
235°F BWR water. No HWC benefit here.

Applies to BNL Part #s with prefix RWCUHX
41-43,45,46,49

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Fatigue loading assumed minor	
7	Low	Medium	Medium	FAT may be accentuated by flow as well as bending. Presence of oxygen accelerates.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Subgroup **26.15**

Various components in lower temp water
304 Stainless Steel (welds assume annealed)
235°F BWR water. No HWC benefit here.

Applies to BNL Part #s with prefix RWCUHX
41-43,45,46,49

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work, water quality and temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	SCC not likely for annealed SS under these conditions	
6	Low	High	High		
7	Medium	High	High	Higher end of this range is rapid SCC.	
8	Low	Medium	High	low confidence score due to uncertain source of sufficient tensile stress	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.1**

Nozzle
304 Stainless Steel and Weld Metal
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
1
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.1**

Nozzle
304 Stainless Steel and Weld Metal
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High	Low temperature	
5	Low	High	High	Not likely for these materials at this temperature	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of SS occurs in 120F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	low confidence score due to uncertain source of sufficient tensile stress	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.2**

Nozzle
304 Stainless Steel HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
1
Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.2**

Nozzle
304 Stainless Steel HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
1
Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	Medium		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	Medium		
4	Low	High	Medium	Low temperature	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Temperature range not well defined but 120F is in the Mills range	
8	Low	High	Medium	Unknown effect of environment and constraint of FR	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.2**

Nozzle
304 Stainless Steel HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
1
Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, sensitization, temperature
3	Low	High	High		
4	Low	High	High	Low temperature	
5	Low	High	High	HAZ is susceptible but temperature is low	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	SCC of SS occurs in 120F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Cracking unlikely at this temperature unless O2 in range 100-200ppb	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.3**

Pipe, elbow, tee, etc.
SA106,216,234 - Carbon Steel Base, Weld, HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
2-6,9-11,13-20,22,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	Medium	Medium	Cyclic stresses of operation including bending and flow; high oxygen	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System**

Reactor Water Cleanup Piping to/from Filters

Subgroup **27.3**

Pipe, elbow, tee, etc.
SA106,216,234 - Carbon Steel Base, Weld, HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
2-6,9-11,13-20,22,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	Not likely for these materials at this temperature	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Low	Medium	Medium	High stresses due to fabrication and other residual sources, high oxygen, temperature in low range where SCC occurs	
8	Low	Medium	High	low confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class especially in this low temperature range	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.4**

Valves
SA216 - Carbon Steel
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
7-8,21,27

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Valves are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.4**

Valves
SA216 - Carbon Steel
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
7-8,21,27

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	Not likely for this material at this temperature	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of carbon steel occurs in 120F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	low confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class especially in this low temperature range	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.5**

Sockolet
304 Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
12,33

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	Medium	Medium	All sockolets may have fatigue issues	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Medium	Medium	High	Fatigue loading uncertain but likely high in this design . Specific characteristics will determine environmental degradation	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.5**

Sockolet
304 Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
12,33

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High	Low temperature	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Temperature range not well defined but 120F is in the Mills range	
8	Low	High	Medium	Unknown effect of environment and constraint of FR	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.5**

Sockolet
304 Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
12,33

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, sensitization, water quality, temperature
3	Medium	High	High		
4	Medium	High	High		
5	Low	High	High	HAZ is susceptible but temperature is low	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC occurs especially at welded and heavily cold worked regions. Accelerated by dissolved oxygen	
8	Low	High	High	Cracking unlikely at this temperature unless O2 in range 100-200ppb	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.6**

Filter nozzles - inlet and outlet
304 Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
24,25,28

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System**

Reactor Water Cleanup Piping to/from Filters

Subgroup **27.6**

Filter nozzles - inlet and outlet
304 Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
24,25,28

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High	Low temperature	
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Temperature range not well defined but 120F is in the Mills range	
8	Low	High	Medium	Unknown effect of environment and constraint of FR	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.6**

Filter nozzles - inlet and outlet
304 Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
24,25,28

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, sensitization, temperature
3	Medium	High	High		
4	Medium	High	High		
5	Low	High	High	HAZ is susceptible but temperature is low	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of SS occurs in 120F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Cracking unlikely at this temperature unless O2 in range 100-200ppb	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.7**

Filter nozzles - inlet and outlet
SA106 - Carbon Steel
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
24,25,28

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.7**

Filter nozzles - inlet and outlet
SA106 - Carbon Steel
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
24,25,28

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	Not likely for this material at this temperature	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of carbon steel occurs in 120F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	High	low confidence score due to uncertain source of sufficient tensile stress and general lack of sustainable cracking in this alloy class especially in this low temperature range	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.8** Filter demin shell, nozzle, fittings….
Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
29-31

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Some problems reported	
5	Low	Medium	High	Possible at high CUFs but not likely here	
6	Low	High	High	Cyclic stress is minor	Cause of cyclic stress
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain . Specific characteristics will determine environmental degradation	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.8** Filter demin shell, nozzle, fittings….
Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
29-31

Notes:

Reduction of Fracture Resistance

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	Medium	Some effect of environment on FR anticipated	Transient loads, presence of defects
3	Low	High	High		
4	Low	High	High		
5	Low	Medium	Medium	In-environment test data not available	
6	Low	High	High	Potential degradation mode but not so significant	Material is not so susceptible to FR
7	Low	Low	Low	Based on Mills work welds are prone to low toughness. However, not well defined for welds beyond his definition. Temperature range not well defined but 120F is in the Mills range	
8	Low	High	Medium	Unknown effect of environment and constraint of FR	

Group **27** **Support System** **Reactor Water Cleanup Piping to/from Filters**

Subgroup **27.8** Filter demin shell, nozzle, fittings….
Stainless Steel - Base, Weld and HAZ
120°F BWR water. HWC not relevant.

Applies to BNL Part #s with prefix RWCUFLTR
29-31

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Risk of SCC depends on level of cold work and water quality but should be low in any case in pure water at this temperature	Stress, cold work, sensitization, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	HAZ is susceptible but temperature is low	
6	Low	High	High	Temperature is low and stress is not high	Cold work hardening is an acceleration factor
7	Medium	Medium	Medium	SCC of SS in 120F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	Cracking unlikely at this temperature unless O2 in range 100-200ppb	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.1**

Nozzle
SA105 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
1

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Only a problem at high CUFs. Not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Nozzles are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain. Environmental degradation will depend on load/time specifics	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.1**

Nozzle
SA105 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
1

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Low	High	High	HWC will be beneficial	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.1**

Nozzle
SA105 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
1

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High	any heavily cold-worked areas could be at risk in NWC; temperature too low for creep mechanisms	
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel in this environment	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel occurs in 435F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	Medium	SCC unlikely to be sustainable . Some concern on confidence and knowledge values a ssociated with the source of stress and the effect of chloride transients and dynamic strain aging (at this temperature) on SCC sustainability	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.1**

Nozzle
SA105 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
1

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	SCC of carbon steel occurs in 435F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	HWC will mitigate SCC in this system	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.2** Piping, elbows, reducing tee, flange…
SA106,216,234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
2-10,13-15,17-18,21-22,24,26

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Only a problem at high CUFs. Not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Piping may have long runs and incur bending stresses as well as flow stresses. Possible thermal gradients.	
8	Low	Medium	High	Fatigue loading uncertain. Environmental degradation will depend on load/time specifics	

Subgroup **28.2**

Piping, elbows, reducing tee, flange…
SA106,216,234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
2-10,13-15,17-18,21-22,24,26

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Low	High	High	HWC will be beneficial	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.2** Piping, elbows, reducing tee, flange…
SA106,216,234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
2-10,13-15,17-18,21-22,24,26

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High	any heavily cold-worked areas could be at risk in NWC; temperature too low for creep mechanisms	
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel in this environment	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel occurs in 435F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	Medium	SCC unlikely to be sustainable . Some concern on confidence and knowledge values a ssociated with the source of stress and the effect of chloride transients and dynamic strain aging (at this temperature) on SCC sustainability	

Subgroup **28.2**

Piping, elbows, reducing tee, flange…
SA106,216,234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
2-10,13-15,17-18,21-22,24,26

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	SCC of carbon steel occurs in 435F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	HWC will mitigate SCC in this system	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.3**

Valves
SA216 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
11-12,16,19-20,23

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High	Fatigue loading assumed minor	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	Only a problem at high CUFs. Not likely here	
6	Low	High	High	Fatigue loading is assumed to be not significant	Prediction model developed
7	Low	High	High	Valves are generally robust and significant fatigue not expected.	
8	Low	Medium	High	Fatigue loading uncertain. Environmental degradation will depend on load/time specifics	

Group **28** **Support System**

Reactor Water Cleanup Piping to Feedwater

Subgroup **28.3**

Valves
SA216 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
11-12,16,19-20,23

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Low	High	High		
4	Low	High	High	Fatigue loading assumed minor	
5	Low	Medium	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Low	High	High	Low oxygen reduces initiation and makes FAT even less likely but not negligible.	
8	Low	High	High	HWC will be beneficial	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.3**

Valves
SA216 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
11-12,16,19-20,23

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High	seems unlikely; should be low stress	
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel in this environment	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC of carbon steel occurs in 535F range with oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	Medium	Medium	SCC unlikely to be sustainable . Some concern on confidence and knowledge values a ssociated with the source of stress and the effect of chloride transients and dynamic strain aging (at this temperature) on SCC sustainability	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.3**

Valves
SA216 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
11-12,16,19-20,23

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	SCC of carbon steel occurs in 535F range but is diminished with low oxygen. SCC occurs especially at welded and heavily cold worked regions.	
8	Low	High	High	HWC will mitigate SCC in this system	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.4**

Weldolet
SA234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
25

Notes:

Fatigue

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	Medium	Medium	Mostl sockolets have fatigue issues	
2	Low	High	High	Fatigue loading assumed to be within code allowable. Possible effect of oxygen on corrosion fatigue for low frequency loading	Fatigue loading, loading frequency and dissolved oxygen
3	Low	High	High	Fatigue loading assumed minor	
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	Fatigue damage due to vibration loading has been observed for some socket welds	
6	Medium	High	High	Well known issue	Prediction model developed
7	Medium	Medium	Medium	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint	
8	Low	Medium	High	Fatigue loading uncertain. Environmental degradation will depend on load/time specifics	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.4**

Weldolet
SA234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
25

Notes:

Fatigue - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Medium	High	High		
2	Low	High	High	Fatigue loading assumed to be within code allowable.	Fatigue loading
3	Medium	High	High		
4	Medium	High	High	Generic problem	
5	Medium	High	Medium	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term fatigue is not clear yet.	Frequency and hydrogen effects are critical.
7	Medium	High	High	Long pipe runs may increase the bending stresses and possibility of cyclic stresses. These geometries have high leverge for fatigue with small pipes fastened to large pipes and bending at the joint. Low oxygen reduces the initiation by pit or CF	
8	Low	High	High	HWC will be beneficial	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.4**

Weldolet
SA234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
25

Notes:

Stress Corrosion Cracking

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Medium	High	High	Risk of SCC depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High	Possible concern if stresses high	
4	Low	High	High		
5	Low	High	High	SCC not likely for C-steel in this environment	
6	Low	High	Medium	SCC in carbon steel with hardening is not clear.	Hardening and dynamic loading(dynamic strain aging) may increase SCC susceptibility in carbon steels
7	Medium	Medium	Medium	SCC occurs especially at welded and heavily cold worked regions. Accelerated by dissolved oxygen	
8	Low	Medium	Medium	SCC unlikely to be sustainable . Some concern on confidence and knowledge values a ssociated with the source of stress and the effect of chloride transients and dynamic strain aging (at this temperature) on SCC sustainability	

Group **28** **Support System** **Reactor Water Cleanup Piping to Feedwater**

Subgroup **28.4**

Weldolet
SA234 - Carbon Steel
435°F BWR water

Applies to BNL Part #s with prefix RWCUFW
25

Notes:

Stress Corrosion Cracking - hydrogen water chemistry

Expert	Susceptibility	Confidence	Knowledge	Rationale:	Factors Controlling Occurrence:
1	Low	High	High		
2	Low	High	High	Low risk of SCC in HWC but also depends on level of cold work and water quality	Stress, cold work, water quality, temperature
3	Low	High	High		
4	Low	High	High		
5	Low	High	High	No significant effect of HWC expected here	
6	Medium	Medium	Medium	Role of hydrogen in long term SCC is not clear yet.	Hydrogen may influence the deformation characteristics and mass transfer kinetics and result in high SCC susceptibility.
7	Low	Medium	Medium	SCC of carbon steel can occur in 435F range but slowly. SCC occurs especially at welded and heavily cold worked regions. Low oxygen reduces SCC.	
8	Low	High	High	HWC will mitigate SCC in this system	