North Anna SLRA

RAI B2.1.7-1: Pitting and Crevice Corrosion in Reactor Vessel Internals

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Dominion's SLRA Recap

- Industry and plant-specific documents confirmed that loss of material due to pitting and crevice corrosion is not an aging effect requiring management for North Anna's reactor vessel internal (RVI) components
  - EPRI Materials Reliability Program
  - Westinghouse Expert Panel Review for North Anna
- The Water Chemistry program (GALL AMP XI.M2) was credited for management of only stress corrosion cracking mechanisms (SCC, IASCC) for RVI components
- SLRA Table 3.1.1 Item 087 was identified as not applicable

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NRC Concerns

- The North Anna PWR Internals program is identified in SLRA B2.1.7 as consistent with GALL AMP XI.M16A
- GALL AMP XI.M16A, Element 2 Preventive Actions, states that the program relies on PWR water chemistry (GALL AMP XI.M2) to prevent/mitigate aging effects due to corrosive aging mechanisms (for example, pitting and crevice corrosion)
- Therefore, NUREG 2191 (SRP) Table 3.1-1 Item 087 should be identified as consistent rather than not applicable

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Dominion's Proposed Path Forward

- The existing North Anna Water Chemistry program (SLRA B2.1.2), consistent with GALL AMP XI.M2 through its Preventive Actions element, is a mitigation program and does not provide for detection of any aging effects of concern for the components within its scope. The main objective of the program is to mitigate loss of material due to corrosion and cracking due to SCC for stainless steel and nickel alloy components exposed to reactor coolant
  - SLRA Section 3.1.2.2.9 is revised to state that pitting and crevice corrosion (in addition to SCC) are mitigated by the Water Chemistry program for RVI components
  - SLRA Table 3.1.1 is revised to indicate that item 3.1.1-087 is consistent with NUREG 2191
  - SLRA Table 3.1.2-2 is revised to add two new generic AMR lines for stainless steel and nickel alloy RVI components that cite Table 1 item 3.1.1-087

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Proposed Section 3.1.2.2.9 Addition

[3.1.1-053a] [3.1.1-053b] [3.1.1-053c] [3.1.1-055c] [3.1.1-059a] [3.1.1-059b][3.1.1-059c] [3.1.1-119] – Electric Power Research Institute (EPRI) Topical Report (TR)-3002017168, "Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227, Revision 1-A)" provides the industry's current aging management recommendations for the reactor vessel internal (RVI) components that are included in the design of a PWR facility.

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The PWR Vessel Internals (B2.1.7) program manages the applicable aging effects for the reactor vessel internal components and the Water Chemistry (B2.1.2) program monitors and controls water environments consistent with industry guidelines to ensure that the reactor coolant water environment is favorable to mitigate SCC and pitting and crevice corrosion in RVI components.

Proposed Table 1 Change

Table 3.1.1 Summary of Aging Management Programs for Reactor Vessel, Internals, and Reactor Coolant System Evaluated in Chapter IV of the GALL-SLR Report

Item Number	Component	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
					aging items are not used.
3.1.1-087	Stainless steel, nickel alloy PWR reactor internal components exposed to reactor coolant, neutron flux	Loss of material due to pitting, crevice corrosion	AMP XI.M2, Water Chemistry	No	Consistent with NUREG-2191. ~~Not applicable. Loss of material due to pitting and crevice corrosion is not an aging effect requiring management for reactor vessel internal (RVI) components exposed to reactor coolant and neutron flux. Westinghouse's expert panel review of MRP-191 Revision 2 for NAPS indicates wear is the only loss of material mechanism for in-scope RVI components. Loss of material due to wear is addressed by rows 3.1.1-054, 3.1.1-059a, 3.1.1-059b, 3.1.1-059c, and 3.1.1-119. The associated NUREG-2191 aging items are not used.~~

Proposed Table 2 Addition

Table 3.1.2-2 Reactor Vessel, Internals, and Reactor Coolant System - Reactor Vessel Internals - Aging Management Evaluation

Subcomponent	Intended Function(s)	Material	Environment	Aging Effect Requiring Management	Aging Management Programs	NUREG-2191 Item	Table 1 Item	Notes
			and neutron flux					
Reactor vessel internal components	FD;SS	Stainless steel	(E) Reactor coolant and neutron flux	Loss of material	Water Chemistry (B2.1.2)	IV.B2.RP-24	3.1.1-087	A
	SS	Nickel alloy	(E) Reactor coolant and neutron flux	Loss of material	Water Chemistry (B2.1.2)	IV.B2.RP-24	3.1.1-087	A

Generic line for reactor vessel internal components will be included in lieu of individual component lines.

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North Anna SLRA

RAI B2.1.15-1:

Diesel-Driven Fire Pump Engine Coolant Heat Exchanger

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Dominion's SLRA Recap

- Diesel-driven fire pump engine and skid-mounted subcomponents were originally addressed in SLRA as an active assembly, not subject to AMR per 10 CFR 54.21(a)(1)(i)
  - Active status is consistent with NUREG-2192, Table 2.1-6 item 55. Equipment performance is managed via Maintenance Rule
  - Similar component was recently questioned at Peach Bottom and active status was accepted in RAI response, documented in SER 2.3.3.14.2
  - Dominion believes Table 2.3-2 excerpt is applicable to diesel generators, not fire pump diesel engines, which typically have integral subcomponents
- Staff noted that the engine coolant HX had experienced a tube failure in 2017; RAI questioned ability of active component testing to identify degradation prior to failure
- Dominion proposed new commitment #49 for periodic replacement in RAI response. Therefore, the HX is not subject to AMR per 10 CFR 54.21(a)(1)(ii).

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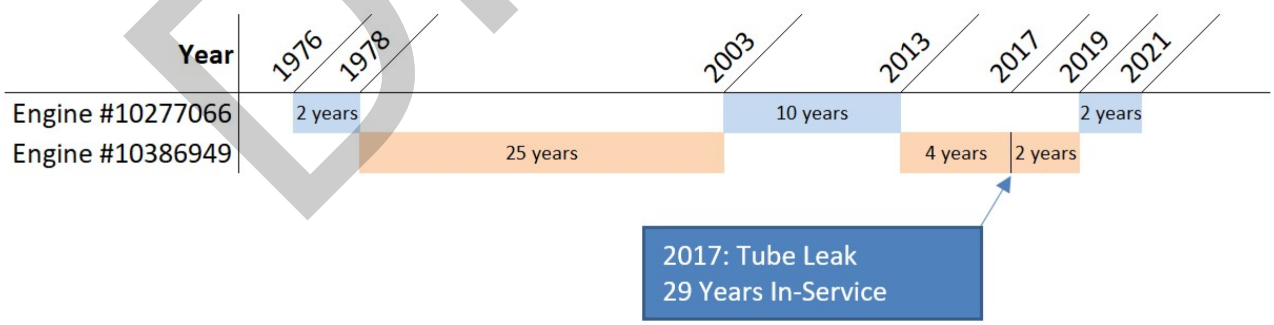
NRC Concerns

- Basis for 20 year periodic replacement frequency

- Two Diesel Assemblies have been in service for the Fire Pump application
  - Engine 1 (Serial #10277066) is currently installed with 14 years of in-service time. No HX OE.
  - Engine 2 (Serial #10386949) had 29 years in service before developing a HX tube leak.
- Dominion Energy believes that a 20 year replacement frequency is conservative based on two engines in service for over 40 years with one HX tube leak. No further actions are required for SLR.

Engine Installation History



Proposed Modified Commitment

Table A4.0-1 Subsequent License Renewal Commitments

#	Program	Commitment	AMP	Implementation
49	N/A	Procedures will be developed to replace the diesel-driven fire pump engine heat exchanger tube bundle on a 20-year frequency ~~and require the heat exchanger tube bundle for the spare engine to be replaced prior to being placed in service with the diesel-driven fire pump.~~ (Added – RAI Set 1)	N/A	Procedures to replace the diesel-driven fire pump heat exchanger tube bundle will be in place 5 years prior to the heat exchanger tube bundle achieving 20 years of active service.

Change made to make commitment applicable to both in-service and spare engines.

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North Anna SLRA

RAI B2.1.27-1: Cyclic Fatigue of Buried Gray Cast Iron Piping Using Jockey Pump Monitoring

RAI B2.1.21-1 Basis for Extent of Inspections For Selective Leaching

RAI B2.1.21-2 Basis of Single 10-foot Sample For Selective Leaching

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May 27 Discussion Topics

- **Current Jockey Pump Monitoring**
- **Enhanced Jockey Pump Monitoring (Enhancement 6)**
- **Jockey Pump Monitoring: Operating Experience**
- **Selective Leaching Extent of Inspections: XI.M35 Considerations**
- **Selective Leaching Extent of Inspections**
- **Selective Leaching Sample Size Selection**
- **Selective Leaching Leading Sample Location**
- **Conclusions**

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Current Jockey Pump Monitoring

- Monitoring the activity of the jockey pump is allowed as an alternative to visual inspections by NUREG-2191 XI.M41 Buried and Underground Piping and Tanks.
- The water-based fire protection system is maintained at required operating pressure (95 to 110 psig) by the jockey pump (30 gpm) and hydropneumatics tank. When the jockey pump can not maintain system pressure due to leakage, the electric motor driven fire pump is auto started, and corrective actions are initiated.
- A low-pressure condition that is beyond the ability of the jockey pump to maintain system pressure is alarmed in the control room by the auto start of the electric motor driven fire pump (90 psig), followed by the start of the diesel-driven fire pump if the system pressure condition continues to decrease (52 psig or 80 psig with elevation difference).
- There are control room vertical board annunciators that provide alarms for the diesel and electric motor driven pumps running or trouble and system initiated and trouble with corresponding operator actions.
- Reference: UFSAR 9.5.1.2 and alarm response procedures

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Enhanced Jockey Pump Monitoring (Enhancement 6)

- Fire Water System Program Enhancement 6: The activity of the jockey pump (i.e. an increase in the number of pump starts or run time of the pump) will be monitored consistent with NUREG-2191 Section XI.M41 Element 4.
- Jockey pump performance information (run time) will be monitored monthly (not-to-exceed) by the program engineer and used to project and prevent unexpected fire pump starts.
- Installation of a jockey pump motor run time totalizer has been requested.
- Further investigations will be performed and corrective actions as appropriate:
  - If jockey pump motor run time projections can not be projected to the next monthly monitoring or an unexpected fire pump start occurs.
  - If an unexpected pump start is not due to a fire system actuation or planned maintenance/testing, then further investigation will be performed to identify/isolate a potential leak.

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Jockey Pump Operating Experience

- The system is designed to sequentially start the fire pumps on decreasing pressure to avoid simultaneous pump starts and the potential for an overpressure event.
- Maintenance, system testing, and/or abnormal plant configurations may result in unexpected pump starts. System procedures have been previously revised to anticipate potential pump starts and often require the electric fire pump to be started as a prerequisite to testing or maintenance.
- There has been no through wall leaks or cracking of buried gray cast iron piping with cementitious lining since 2003.
- A review of the last 5 years of condition reports identified 6 unexpected pump starts:
  - 2 diesel pump starts with electric pump running during transformer deluge testing
  - 4 electric pump starts with warehouse cross-tie open due to warehouse fire protection maintenance or diesel/motor pump maintenance
  - Unexpected pump starts were not simultaneous or due to system leakage
- A recent condition report was initiated to investigate avoiding unnecessary pressure events

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Selective Leaching Extent of Inspection: XI.M35 Considerations

Prior to the SPEO, extent of inspections for cracking of buried gray cast iron piping that is cementitiously lined will be consistent with **Category B** of AMP XI.M35, ASME Code Class 1 Small Bore Piping.

Category	Plant OE	Mitigation	Examination Schedule	Sample Size	Examination Method
A	No age-related cracking	Not applicable	One-time completed within 6 years prior to start of SPEO	3% of total population per Unit up to 10 max	Volumetric or destructive
B	No age-related cracking	Yes	One-time completed within 6 years prior to start of SPEO	10% of total population per Unit up to 25 max	Volumetric or destructive
C	Age-related cracking	No	Periodic completed within 6 years prior to start of SPEO with exams every 10 years thereafter	10% of total population per Unit up to 25 max	Volumetric or destructive

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Selective Leaching Extent of Inspection

Extent of inspections for cracking and loss of material of cementitiously lined buried gray cast iron fire protection piping is based on one-time, periodic and opportunistic inspections that consider:

- One-time inspections prior to the SPEO (c/w XI.M35):
  - Sample size: 10% of the total population up to maximum of 25 components per Unit This more than triples the XI.M33 inspections (i.e. 25 vs 8) prior to the SPEO
  - Exam Method: visual or destructive exams with destructive exams credited twice toward the total sample – minimum of 3 destructive exams
- Periodic inspections in the SPEO (c/w XI.M33):
  - Sample size: 3% of the total population up to maximum of 8 components per Unit
  - Exam Method: visual or destructive exams with destructive exams credited twice toward the total sample – mandatory 2 destructive exams in addition to total of 8
- Opportunistic: Opportunistic inspections using enhanced jockey pump monitoring are credited as periodic or one-time inspections as long as sample selection criteria are met – assume one or two excavations per period

Selective Leaching Sample Size Selection

Inspection samples will be harvested by excavating 10-foot piping segments. Each excavated piping segment will provide 10 samples for visual or destructive examinations.

- Selection of piping excavation location consistent with leading sample criteria
- The fire protection system is a common system to Unit 1 and Unit 2. Due to the ductile piping replacement on Unit 2, excavations for piping within the scope of license renewal will be performed independent of Unit designator and based on leading sample criteria
- NUREG-2191 considers each 1-foot piping segment (or equivalent 1-foot segment) as 1 component: M33, M36, M38 (any combination of 1-foot lengths), M41 (inspections based on 10-foot lengths), and M42
- Excavating 10-foot piping segments for inspection is consistent with NUREG-2191 XI.M41 Based on Table XI.M41-2 for cathodic protection meeting availability and effectiveness performance criteria, one inspection of a 10-foot piping length of buried gray cast iron piping would be required every ten years
- Opportunistic inspections based on enhanced jockey pump monitoring to target specific piping leakage issues will augment periodic sampling – informed opportunistic inspections as a result of enhanced jockey pump monitoring are an efficient use of resources

Selective Leaching Leading Sample Location

Based on operating experience, inspection locations focused on the bounding or lead piping most susceptible to aging

- Older piping segments (i.e. not previously replaced)
- Piping found to be continuously wetted due to leaking piping/valves or in soil with high corrosivity ratings as determined by EPRI Report 3002005294
- Piping that is not cathodically protected
- Piping with significant coating degradation or unexpected backfill
- Consequence of failure (i.e. proximity to safety-related piping)
- Pipe locations with potentially high stress and/or cyclic loading conditions such as piping adjacent to locations that were replaced due to cracking/rupture, locations subject to settlement, or locations subject to heavy load traffic

Conclusions

The previous information demonstrates with reasonable assurance that the intended function of the buried lined gray cast iron fire protection piping will be maintained throughout the subsequent period of extended operation.

- Enhanced jockey pump monitoring and trending using pump run time projections to prevent unexpected fire pump starts due to leakage will be implemented prior to the SPEO
- Opportunistic inspections including those based on enhanced jockey pump monitoring to target specific piping leakage issues will efficiently augment sampling inspections
- Selective Leaching program extent of inspections are appropriate based upon one-time inspections (pre-SPEO), periodic inspections (SPEO), opportunistic inspection informed by enhanced jockey pump monitoring, continued use of in-house metallurgical lab for destructive examinations, and AMP effectiveness/OE
- Selective Leaching one-time inspections (pre-SPEO) more than triples the XI.M33 inspections with 50 components rather than 16 components inspected at both Units
- Selective Leaching periodic inspections (SPEO) are consistent with XI.M33
- Selection of periodic Selective Leaching program piping excavation locations are consistent with NUREG-2191 guidance for other piping segment inspections and will be consistent with leading sample criteria

North Anna SLRA

RAI B2.1.35-1:

Settlement Monitoring: Service Water Valve House (Settlement Marker SM-28)

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Dominion's SLRA Recap

- Settlement monitoring of Class I structures is governed by TRM 3.7.7. Per the TRM, if a monitored location exceeds 75% of the TRM allowable settlement:
  - TRM requires a Condition Report (CR) be submitted immediately;
  - Within 60 days, engineering is to review field conditions and evaluate the consequences of additional settlement.
  - If a monitored location exceeds 100% of the TRM allowable settlement, the affected unit is to be in MODE 3 within 6 hours, and MODE 5 within 36 hours.
- On April 21, A CR was submitted to note that settlement of SM-28, which is associated with the SWVH, had slightly exceeded 75% of the TRM 3.7.7 allowable value (current SM-28 settlement is 75.6% of the allowable).
- As noted in the CR, there is no challenge to the functionality of plant equipment, and based on data, settlement of SM-28 is projected to remain below the 100% allowable settlement limit established in TRM 3.7.7 until at least 2036.

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Dominion's SLRA Recap, cont.

- As further noted in TRM 3.7.7 bases, the allowable settlement for SM-28, as well as other SWVH settlement markers, is based on limiting SW pipe stresses.
  - To address potential future SWVH settlement, SW piping expansion joint tie-rods will be adjusted to allow for additional settlement.
  - After SW Piping expansion joint tie-rods adjustments, the allowable settlement for the SWVH settlement markers will be re-baselined to the expansion joint tie-rod adjustment date (Note that this approach is similar to the approach taken in 2009).
- Dominion Energy believes that the CLB and the oversight of the regulatory framework will ensure appropriate actions are taken as delineated in TRM 3.7.7 prior to the SPEO. No further actions are required for SLR.