TENNESSEE VALLEY AUTHORITY

Browns Ferry Nuclear Plant Subsequent License Renewal Application

Buried and Underground Piping

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Introduction

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Agenda

Introduction – Pete Donahue

Background – Paul Anglin

Browns Ferry Nuclear Plant (BFN) SLR Aging Management Program (AMP) – Paul Anglin

- Coatings
- Soils
- Operating Experience (OE)
- SLR Inspections
- SLR Cathodic Protection Evaluation

BFN Subsequent License Renewal Application (SLRA) Information – Paul Anglin

Summary – Pete Donahue

NRC Questions/Comments

Background

Scope

- Manages aging of external surfaces of buried and underground piping and tanks

  Note: BFN has no tanks within scope of SLR Buried and Underground Piping and Tanks AMP

Construction

- Construction of BFN began in 1966
- Cathodic Protection (CP) not included as part of original design and not added following construction

Background (continued)

BFN Existing Program

- Relies on coatings and inspections for aging management
- Preventive measures to mitigate corrosion
  - In-scope Carbon Steel Buried Piping was coated to American Water Works Association (AWWA) C203-66 coating standard during initial construction
    - This coating is in accordance with Table 1 of National Association of Corrosion Engineers (NACE) SP0169-2007
  - Maintenance and modifications are performed consistent with BFN design requirements and processes
- Inspections to manage the effects of corrosion
  - Opportunistic inspections are required for in-scope piping and components

BFN SLR Aging Management Program

BFN SLR Buried and Underground Piping and Tanks AMP

- Exception to GALL-SLR AMP XI.M41 Element 2, Preventative Actions because BFN does not have CP
- Based on high quality coating, plant-specific soil characteristics, and plant-specific OE, plus enhancements to existing AMP

Notable Enhancements to BFN SLR AMP

- Periodic inspections in addition to currently required opportunistic inspections
  - For periodic inspections: site OE, high risk ranking, and results from soil analysis combined with results from pipe-to-soil surveys, to be used as inputs to determine locations
  - Periodic inspections will include areas with factory-applied to field-applied coating interfaces
- Inspections will be performed by a qualified coatings inspector

BFN Coatings

AWWA C203-66 A1.5

- Robust multi-layer coating system intended for extraordinary soil conditions that has also been shown to be immune to corrosion due to soil microbes
  - Primer
  - Coal-tar enamel
  - Fibrous glass mat
  - Coal-tar enamel
  - Bonded asbestos felt
  - Whitewash or kraft paper
- All piping not mill coated, all fittings, and all welded connections are coated using coal-tar protective coating in tape form
- Field application process in accordance with BFN design requirements and processes

BFN Soils

Soil Sampling and Analysis

- In 2009, soil sampling and analysis conducted
  - 13 samples (11 within site protected area and 2 near cooling towers)
    - Sample locations have Electric Power Research Institute (EPRI) soil corrosivity indices of 4-9
- In 2023, comprehensive soil sampling and analysis effort
  - In-scope systems identified and eight representative sample locations selected around the site
  - Samples were evaluated for various parameters including, but not limited to: Resistivity; pH; Redox; Potential; Sulfides; Chlorides; Moisture; Soil Consortia
  - Results of sample analysis
    - Sample locations have EPRI soil corrosivity indices of 7-8
- Per GALL-SLR Section IX.D, Use of Terms for Environments
  - BFN pH, chlorides, and sulfate levels classify soil as non-aggressive

BFN Operating Experience

Operating Experience of Coatings on Buried Piping

- Current BFN program requires visual inspection of piping when excavated for any reason
  - BFN inspections include visual evaluations of coatings
  - BFN procedures require initiation of a condition report (CR) in the Corrective Action Program to document any cases of coating degradation identified during inspections
    - Results of review
  - 100 visual inspections, performed since 2004, were reviewed
    - 36 of these inspections were for in-scope piping or similar material/environment piping as specified in GALL-SLR
      - Only identified coating anomalies were result of pipe failure due to internal initiation (e.g., internal failure of pipe weld)

Residual Heat Removal Service Water Pipe (Top) and
Emergency Equipment Cooling Water Pipe (Bottom)
June 2010 – Prior to Coating Removal

Residual Heat Removal Service Water Pipe (Top) and
Emergency Equipment Cooling Water Pipe (Bottom)
June 2010 – Coating Removed

BFN SLR Inspections

SLR Inspections – Opportunistic and Periodic

- Opportunistic Inspections
  - Existing plant procedures and processes require inspection of buried piping whenever it is excavated – to be continued for SLR
  - Inspections will be performed by a qualified coatings inspector
    - Coatings inspector shall have completed EPRI Comprehensive Coating Course and EPRI Buried Pipe Condition Assessment and Repair Training Course, or equivalent courses as identified in GALL-SLR
- Periodic Inspections
  - Locations selected based upon:
    - Site OE
    - High Risk Ranking (BPWORKS™)
    - Indirect inspection results
      - Soil analysis combined with pipe-to-soil surveys

BFN SLR Inspections

SLR Inspections – Periodic

- 12 excavation locations identified

Dig #	Nearest Sample Location	Driver	
Dig 1	1-3	Soil corrosivity and Pipe-to-soil Potential	RSCS
Dig 2	1-8	Soil corrosivity and Pipe-to-soil Potential	RSCS
Dig 3	Alt-1	Pipe-to-soil Potential	RSCS
Dig 4	3	Soil corrosivity and APEC Pipe-to-soil Potential	SIA
Dig 5	1	CorrTech Close interval survey, and APEC survey	SIA
Dig 6	Area 1	CIS survey lowest area potentials maybe mixed metal influence	RSCS
Dig 7	1-5	Soil corrosivity and high LPR rate	RSCS
Dig 8	10	APEC Survey soil corrosivity	SIA
Dig 9	1-2	CIS survey lowest area potentials maybe mixed metal influence	RSCS
Dig 10	11	Soil Corrosivity and APEC	SIA
Dig 11	9	APEC Survey	SIA
Dig 12	8	APEC and soil corrosivity high corrosion rate	SIA

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BFN SLR Inspections

SLR Inspections – Periodic (continued)

- Periodic inspections and intervals (buried carbon steel piping)
  - Inspection schedule for the 12 excavation locations

    (Based on GALL-SLR AMP Table XI.M41-2 Category E)
    - 6 inspections within 10-year period prior to entry into subsequent period of extended operation (Dig 1 though Dig 6)
    - 6 inspections during the first 10-year period during subsequent period of extended operation (Dig 7 through Dig 12)
    - Based on results of these 12 excavations and any opportunistic inspections, 6 additional locations will be selected for inspection for the last 10-year period during the subsequent period of extended operation
  - Inspections for other piping within scope of SLR Buried and Underground Piping and Tanks AMP (e.g., underground steel piping) will be in accordance with GALL-SLR AMP Table XI.M41-2

BFN SLR Inspections

SLR Inspections – Periodic (continued)

- Periodic inspections will include:
  - Soil sampling
    - Using guidance in EPRI Buried and Underground Piping and Tank Reference Guide
  - Inspections performed by a qualified coatings inspector
  - Inspections of a field applied coating section, for example fittings, or field weld locations and interface with the mill applied coating
  - Pipe-to-soil potential measurements readings in the excavation and adjacent to the excavation
  - Documentation of As-found and As-left inspection results

BFN SLR CP Evaluation

Evaluation of Cathodic Protection Installation

- CP not included in the original design and has not been added following construction
  - Therefore, the current Buried and Underground Piping AMP does not rely on CP
- BFN site geology is not conducive for CP
- Relatively shallow bedrock does not transmit CP current effectively
- Not all piping is electrically contiguous
- Potential for stray current to damage unprotected systems and structures
- Shielding from buildings and other underground structures

BFN SLRA Information

AMP Exception/Justification for No Cathodic Protection

- Description of high quality coatings installed at BFN
- Discussion of soil sample locations, soil sample results, the methodology and results of how the overall soil corrosivity was determined, pipe-to-soil potential measurements and other relevant parameters
- Discussion of plant-specific OE
  - Results of the following expanded plant-specific OE search will be included in the SLRA
    - BFN review of most recent 10 years of plant-specific OE to determine whether degraded conditions that would not have met the acceptance criteria of GALL-SLR AMP XI.M41 have occurred
    - Search includes components that are not in-scope for license renewal if, when compared to in-scope piping, they are of similar materials and coating systems and are buried in a similar soil environment
- Description of applicable AMP enhancements

Summary

- High Quality Coatings
- Non-aggressive Soils
- Site Operating Experience Validates Effectiveness of Coatings
- Enhancements Beyond GALL-SLR Guidance
- Installation of Cathodic Protection Would Have Limited Effectiveness

NRC Questions/ Comments

Abbreviations List

APEC	Area Potential Earth Current
AMP	Aging Management Program
AWWA	American Water Works Association
BFN	Browns Ferry Nuclear Plant
CIS	Close Interval Survey
CP	Cathodic Protection
CR	Condition Report
EPRI	Electric Power Research Institute
GALL-SLR	Generic Aging Lessons Learned for Subsequent License Renewal
LPR	Linear Polarization Rate
NACE	National Association of Corrosion Engineers
NRC	Nuclear Regulatory Commission
OE	Operating Experience
SLR	Subsequent License Renewal
SLRA	Subsequent License Renewal Application


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