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Washington, DC 20555-0001

Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413 and 50-414,
Renewed License Nos. NPF-35 and NPF-52

Subject: Request for Acceptance of Proposed Method to Manage Aging due to Environmentally Assisted Fatigue (EAF) for the Safety Injection Nozzle

References:

1. NRC Letter to Duke Energy, *License Renewal Safety Evaluation Report for McGuire, Units 1 and 2, and Catawba, Units 1 and 2*, dated January 6, 2003 (ML030090122)

2. NUREG-1772, *Safety Evaluation Report Related to the License Renewal of McGuire Nuclear Station, Units 1 and 2, and Catawba Nuclear Station, Units 1 and 2* (ML030850251)

Per the above references, Duke Energy Carolinas, LLC (Duke Energy) is committed to address the effects of environmentally-assisted fatigue (EAF) for several fatigue-sensitive locations, including the safety injection nozzle, during the period of extended operations. As stated in Reference 2:

> *The applicant agreed not to use the flaw tolerance/inspection procedures specified in Note 1 unless such procedures have been accepted by the NRC.*

Duke Energy intends to manage the aging effects of EAF on the safety injection nozzle through flaw tolerance evaluation and inspections. Accordingly, Enclosure 1 provides the description of the flaw tolerance evaluation and proposed inspections that Duke Energy plans to use for the safety injection nozzle. Duke Energy requests NRC review and approval of the proposed method provided in Enclosure 1.

There are no new regulatory commitments contained in this letter.

Questions regarding this submittal should be directed to Mr. Lee Grzeck, Fleet Licensing Manager (Acting), at (980) 373-1530.

Sincerely,

Tom Simril
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Enclosure:

1. Description of the Proposed Method to Manage Aging due to Environmentally Assisted Fatigue for the Safety Injection Nozzle

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Enclosure 1

Description of the Proposed Method to Manage Aging due to Environmentally Assisted Fatigue for the Safety Injection Nozzle

1. BACKGROUND

The Duke Energy Corporation (Duke) license renewal application for McGuire, Units 1 and 2, and Catawba, Units 1 and 2 (Reference 5.1) identified the effects of environmentally-assisted fatigue (EAF) as an issue, and stated in Section 4.3.1.2:

> *However, since NUREG/CR-6674 [Reference 4.3 - 5] indicated that fatigue reactor coolant environmental effects would result in an increased frequency of pipe leakage, the NRC required that utilities applying for license renewal address the effects of reactor water environment on fatigue usage in affected components.*

Duke proposed the following approach:

1. Choose 6-10 plant locations for assessment.
2. For an evaluation period, determine the EAF-adjusted cumulative usage factor (CUF) at these locations, using defined transient severities and/or assumed occurrences, either bounding or coinciding with realistic expectations.
3. Within the evaluation period, continually track the fatigue accumulating at the locations.
4. Compare either the recorded incidences of occurring transients with the number used in step 2, or compare the calculated EAF-adjusted CUF with that predicted in step 2.
5. Make future projections of either the EAF-adjusted CUF or the count of transient occurrences to determine the remaining time to reaching the allowable.

Note 1 to this strategy indicated that, if the EAF-adjusted CUF could not be shown to remain below 1.0, then the alternatives from Draft EPRI Report, *Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application*, Electric Power Research Institute, (including Flaw Tolerance and Inspection) would be used.

For Catawba Units 1 and 2 (CNS), the location of concern for EAF-adjusted CUF is the safety injection nozzle.

In the Safety Evaluation Report (Reference 5.2) it states:

> *The applicant agreed not to use the flaw tolerance/inspection procedures specified in Note 1 unless such procedures have been accepted by the NRC. In addition, the applicant agreed to revise the procedure specified in LRA Section 4.3.1.2 to set Z equal to 1.0. The staff finds these commitments acceptable.*

Duke intends to manage the aging effects associated with EAF on the safety injection nozzle with a combination of inspections and flaw tolerance evaluation. Accordingly, Sections 2, 3, and 4 provide the flaw tolerance evaluation description, inspection attributes, and implementation plan for NRC Staff review and approval.

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2. FLAW TOLERANCE EVALUATION DESCRIPTION

The CNS safety injection nozzle evaluations are based on the flaw tolerance approach documented in the ASME Boiler and Pressure Vessel Code, Section XI – Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components, Non-Mandatory Appendix L, *Operating Plant Fatigue Assessment*.

The evaluations were performed in accordance with the requirements of the 2013 Edition of the ASME Code, Section XI, Appendix L. Effective August 17, 2017, the latest ASME Code edition approved by the NRC is the 2013 Edition, which includes Section XI, Appendix L. Code Case N-809, which includes the latest crack growth data, has been approved by ASME and endorsed by the NRC (Reference 5.4). The NRC has also reviewed and approved a similar submittal pertaining to fatigue for McGuire Nuclear Station (Submittal: ML20157A077 and Approval: ML21082A433).

2.1 ASME Section XI Appendix L Analysis of the CNS Safety Injection Nozzle

A fatigue flaw tolerance evaluation was performed specifically for CNS, to assess the operability of the safety injection nozzle by using ASME Section XI, Appendix L, methodology, and to determine the successive inspection interval for the safety injection nozzle with a postulated surface-connected flaw. Both the axial and circumferential flaws were acceptable for 60 years of operation, with the flaw depth ratio (a/t) well below the allowable values. The results of the crack growth for the safety injection nozzle are presented in Table 1.

(Reference 5.3)

Table 1

Safety Injection Nozzle Crack Growth Results

Flaw Type	Path	Year	Final Flaw Size					Allowable a/t
			a	c, inch	L, inch	L, deg	a/t	
Axial	P1	60	0.0472	0.2085	0.4170	--	0.1605	0.75
	P2	60	0.0481	0.2089	0.4178	--	0.1808	0.75
Circ	P1	60	0.0599	0.2170	0.4340	36.35	0.2252	0.4677
	P2	60	0.0614	0.2180	0.4360	36.52	0.2308	0.4667

2.2 Inspection Schedule

Per the guidelines of Appendix L, Table L-3420-1, the successive inspection schedule for the safety injection nozzle is determined to be ten years for either an axial or a circumferential postulated flaw. This inspection interval will be used for the safety injection nozzle as noted in Table 2.

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3. INSPECTION PROGRAM ATTRIBUTES

The attributes of the CNS Safety Injection Nozzle Inspection Program are discussed below:

1. Scope of the Inspections

   The safety injection nozzle welds listed in Table 2, *Safety Injection Nozzles – Inspection Summary* will be examined in accordance ASME Section XI, IWB under the CNS Risk-Informed ISI Program for Class 1 welds. The aging effect managed with these inspections is cracking due to environmentally-assisted fatigue. In each 10-year ISI interval during the period of extended operation, the eight safety injection nozzle welds (four per unit) will be inspected.

   Based on the flaw tolerance analyses, and per the guidelines of ASME Code, Section XI, Appendix L, Table L-3420-1, the successive inspection schedule is determined to be ten years. This inspection interval will be used for all welds in scope.

   Examination methods are determined in accordance with the requirements of the Risk Informed Inservice Inspection (RI-ISI) Programs for Class 1 piping welds. Inservice Inspection of ASME Class 1 and 2 piping welds at Catawba (Categories B-F, B-J, C-F-1 and C-F-2) is being performed in accordance with a Risk Informed Inservice Inspection (RI-ISI) Program per Section XI Code Case N-716-1. The Risk Informed Inservice Inspection Program does not require a surface examination to be performed for these category welds. Examination results are evaluated by qualified individuals in accordance with ASME Section XI acceptance criteria. Components with indications that do not exceed the acceptance criteria are considered acceptable for continued service.

2. Preventive Actions

   There are no specific preventive actions under this program to prevent the effects of aging.

3. Parameter(s) Monitored or Inspected

   Inservice examinations for the safety injection nozzle welds will be volumetric examinations as indicated in Table 2.

4. Detection of Aging Effects

   The management of degradation of the safety injection nozzle welds is accomplished by volumetric examination in accordance with the requirements of the CNS ISI Program. The frequency and scope of examinations are demonstrated to be sufficient to ensure that aging effects are detected before the integrity of the safety injection nozzle would be

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compromised.

5. Monitoring and Trending

The frequency and scope of the examinations are sufficient to ensure that the environmentally-assisted fatigue aging effect is detected before the intended function of these welds would be compromised. Examinations will be performed in accordance with the inspection intervals based on the results of the postulated flaw evaluation performed in accordance to the ASME Code Section XI, Appendix L methodology.

Flaws identified in the safety injection nozzle welds will be evaluated by engineering to assess the effect of EAF and to determine impacts on the EAF analysis.

Records of the examination procedures, results of activities, examination datasheets, and corrective actions taken or recommended will be maintained in accordance with the requirements of CNS ISI Program and ASME Section XI.

6. Acceptance Criteria

Acceptance standards for the ISI examinations are identified in Subsection IWB for Class 1 components. Table IWB-2500-1 identifies references to acceptance standards listed in IWB-3500. Flaws found in the safety injection nozzle welds that are revealed by the volumetric examination require additional evaluation per the requirements of ASME Section XI.

Flaws that exceed the acceptance criteria will be entered into the Duke Corrective Action Program. Safety injection nozzle welds with flaws that do not meet the acceptance standards of ASME Section XI, IWB-3500, will be corrected either by repair, replacement or analytical evaluation.

Repairs or replacements will be performed in accordance with ASME Section XI, Subsection IWA-4000, as described in administrative procedure AD-EG-ALL-1703, *ASME Section XI Repair/Replacement Program Administration*.

7. Corrective Actions

Action Requests are generated in accordance with the Duke Corrective Action Program for flaws that exceed the acceptance criteria. Items with examination results that do not meet the acceptance criteria are subject to acceptance by analytical evaluation per subsection IWB-3600 and/or acceptance by repair or replacement in accordance with Subsection IWA-4000.

8. Confirmation Process

When degradation is identified in safety injection nozzle welds, an engineering evaluation is performed to determine if they are acceptable for continued service or if

repair or replacement is required. The engineering evaluation includes probable cause, the extent of degradation, the nature and frequency of additional examinations, and, whether repair or replacement is required.

Repair and replacement are performed in accordance with the requirements of ASME Section XI, Subsection IWA-4000, and as implemented by CNS administrative procedure AD-EG-ALL-1703, *ASME Section XI Repair/Replacement Program Administration*.

9. Administrative Controls

The CNS ISI Program will document the EAF inspection requirements for the CNS safety injection nozzle welds under the ASME Section XI ISI Program. Site Quality Assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B of 10 CFR Part 50 and will continue to be adequate for the PEO.

Procedures utilized include:
(1) AD-PI-ALL-0100, Corrective Action Program
(2) AD-EG-ALL-1702, ASME Section XI Inservice Inspection Program Administration
(3) AD-EG-ALL-1703, ASME Section XI Repair/Replacement Program Administration

10. Operating Experience

All safety injection nozzle welds were inspected in 2021 for both Units 1 and 2. The programmatic operating experience activities described in relevant station procedures ensure the adequate evaluation of operating experience on an ongoing basis to address age-related degradation and aging management for the safety injection nozzle.

The CNS operating experience aligns with industry operating experience for Arkansas Nuclear One, Unit 2 (ACN: ML18144A970, and McGuire (ACN: ML20157A077) as described in their submittals to manage the effects of aging due to EAF through a combination of inspections and flaw tolerance evaluations.

The proposed inspections to examine the safety injection nozzle welds listed in Table 2, for ISI intervals listed in the schedule of inspections in accordance with IWB-2410, provide reasonable assurance that potential environmental effects of fatigue will be managed such that the safety injection nozzles will continue to perform their intended function throughout the PEO.

4. IMPLEMENTATION PLAN

Upon approval of the proposed inspection program, related aging management program basis and implementing documents and the associated Updated Final Safety Analysis Report (UFSAR) sections will be updated accordingly.

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5. REFERENCES

5.1 Letter from M.S. Tuckman (Duke) to USNRC, Application to Renew the Operating Licenses of McGuire Nuclear Station, Units 1 & 2 and Catawba Nuclear Station, Units 1 & 2, Docket Nos. 50-369, 50-370, 50-413 and 50-414, dated June 13, 2001

5.2 NUREG-1772, Safety Evaluation Report Related to the License Renewal of McGuire Nuclear Station, Units 1 and 2, and Catawba Nuclear Station, Units 1 and 2, March 2003 (ACN: ML030850251)

5.3 CNC-1206.02-45-0004, Flaw Tolerance Evaluation of Catawba Nuclear Station, Units 1 and 2, Boron Injection Nozzles using ASME Code Section XI, Appendix L, Revision 0 (SIA File No. 1800359.401)

5.4 Regulatory Guide 1.147, Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1, Revision 20

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Table 2

CNS 1.5" Safety Injection Nozzle Welds – Inspection Summary

Unit	Item No.	Component Description	Weld No. (Summary No.)	Last Examination Performed and Results	Allowable Operating Period per ASME App. L Analysis (See Note 1)	Proposed Inspections During PEO Type/ Frequency
1	1	Cold Leg 1A Nozzle 1-1	1NC51-01 (C1-10329)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
	2	Cold Leg 1B Nozzle 2-1	1NC42-01 (C1-10325)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
	3	Cold Leg 1C Nozzle 3-1	1NC82-01 (C1-10335)	2021 Limited	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
	4	Cold Leg 1D Nozzle 4-2	1NC43-11 (C1-10327)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
2	1	Cold Leg 2A Nozzle 1-1	2NC141-07 (C2-09881)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
	2	Cold Leg 2B Nozzle 2-1	2NC145-06 (C2-09882)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
	3	Cold Leg 2C Nozzle 3-1	2NC146-06 (C2-09884)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years
	4	Cold Leg 2D Nozzle 4-2	2NC140-05 (C2-09880)	2021 Satisfactory	Greater than 10 years	Volumetric Once per interval not to exceed 10 years

Note 1: The inspection frequency as determined by ASME Code Section XI, Appendix L analysis is more than 10 years. In accordance with the requirements of Appendix L Table L-3420-1, the safety injection nozzle welds will be examined once per 10 years.