




Duke Energy Pre-Submittal Meeting – November 18, 2019

DUKE ENERGY®

Request for Alternative RA-19-0352

Duke Energy Request for Alternative for Reactor Vessel Closure Stud Exam Extensions

Brunswick Steam Electric Plant (BNP)
Catawba Nuclear Station (CNS)
Harris Nuclear Power Plant (HNP)
McGuire Nuclear Station (MNS)
Oconee Nuclear Station (ONS)
Robinson Steam Electric Plant (RNP)

Participants

- Mark Pyne, ISI Engineering Programs Manager – Duke Energy
- Austin Keller, Senior Nuclear Engineer – Duke Energy
- Art Zaremba, Fleet Licensing Manager – Duke Energy
- Chet Sigmon, Senior Nuclear Engineer – Duke Energy
- Robert Grizzi, Program Manager – EPRI
- Gary Stevens, Technical Executive – EPRI
- Douglas Kull, Principal Technical Leader – EPRI
- John Broussard, Principal Engineer – Dominion Engineering, Inc.

Key Goals for This Meeting:

- Brief NRC on Duke's proposed Request for Alternative, project scope, and proposed timeline
- Ensure common understanding for Duke Energy's request, technical scope, and regulatory expectations
- Obtain NRC feedback prior to formal submittal

Agenda

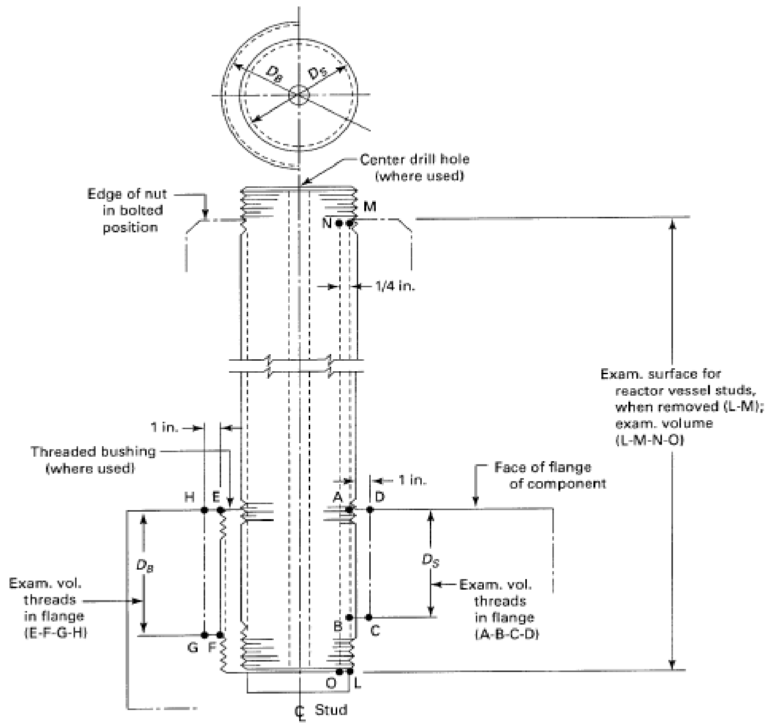
I. Description of Request
II. Regulatory Requirements and Guidance
III. Proposed Alternative
IV. EPRI Technical Report
V. Conclusion / Schedule

Background:

- Affected components: Reactor Vessel Closure Studs
- ASME Section XI, Table IWB-2500-1, Exam Category B-G-1, Item B6.20 require volumetric exams once during each Section XI Interval with exam volume shown in Figure IWB-2500-12.
- Additionally, per Note (7) of Table IWB-2500-1 (B-G-1), "when bolts or studs are removed for examination, surface examination meeting the acceptance criteria of IWB-3515 may be substituted for volumetric examination." The surface examination area is the stud external surface along the entire engaged length of the stud, as shown in ASME Section XI Figure IWB-2500-12.

I. Description of Request

FIG. IWB-2500-12 CLOSURE STUD AND THREADS IN FLANGE STUD HOLE
(1 in. = 25 mm, ¼ in. = 6 mm)



D_B = diameter of the threaded bushing
D_S = diameter of the stud

II. Regulatory Requirements and Guidance

- 10 CFR 50.55a “Codes and Standards”
- ASME Section XI IWB-2500(a), Table IWB-2500-1, Examination Category B-G-1, Item No. B6.20
- 10 CFR 50.55a(z)(1)

III. Proposed Alternative

- Duke Energy is requesting an alternative to the examination requirements of ASME Section XI, Table IWB-2500-1 (B-G-1), Examination Category B-G-1, Item B6.20.
- The proposed alternative is to extend the frequency of reactor vessel closure stud volumetric or surface examinations past the remainder of the currently licensed operating periods for the plants listed in Table 1. The current licensing periods for these plants are summarized in Table 2.
- Duration of Proposed Alternative:
  - The proposed alternative is requested for the remainder of the currently licensed 60 year operating periods for the plants listed in Tables 1 and 2.

Table 1: Plants Included in This Request for Alternative and Their Current ISI Intervals and Applicable ASME Code Section XI Editions/Addenda

Plant/Unit(s)	ISI Interval	ASME Section XI Code Edition/Addenda	Interval Start Date	Interval End Date
Brunswick Steam Electric Plant Units 1 and 2 (BWR)	Fifth	2007 Edition, Through 2008 Addendum	05/11/2018	05/10/2028
Catawba Nuclear Station Units 1 and 2 (PWR)	Fourth	2007 Edition, Through 2008 Addendum	08/19/2015	12/06/2024 (Unit 1) 02/24/2026 (Unit 2)
H.B. Robinson Steam Electric Plant Unit 2 (PWR)	Fifth	2007 Edition, Through 2008 Addendum	07/21/2012	02/19/2023
McGuire Nuclear Station Units 1 and 2 (PWR)	Fourth	2007 Edition, Through 2008 Addendum	12/01/2011 (Unit 1) 07/15/2014 (Unit 2)	11/30/2021 (Unit 1) 12/14/2024 (Unit 2)
Oconee Nuclear Station Units 1, 2, and 3 (PWR)	Fifth	2007 Edition, Through 2008 Addendum	07/15/2014	07/15/2024
Shearon Harris Nuclear Power Plant Unit 1 (PWR)	Fourth	2007 Edition, Through 2008 Addendum	09/09/2017	09/08/2027

Table 2: Current ISI Intervals and License Periods

Plant/Unit	Current License Period End Date	Date of Last Category B-G-1 Examination	Duration of Alternative (years)
Brunswick Unit 1 (BWR)	09/08/2036	03/30/2018	18
Brunswick Unit 2 (BWR)	12/27/2034	04/11/2017	17
Catawba Unit 1 (PWR)	12/05/2043	12/05/2015	28
Catawba Unit 2 (PWR)	12/05/2043	03/19/2015	28
H. B. Robinson Unit 2 (PWR)	07/31/2030	02/17/2012	18
McGuire Unit 1 (PWR)	03/03/2041	03/31/2013	27
McGuire Unit 2 (PWR)	03/03/2043	09/19/2015	27
Oconee Unit 1 (PWR)	02/06/2033	11/12/2014	18
Oconee Unit 2 (PWR)	10/06/2033	10/22/2015	17
Oconee Unit 3 (PWR)	07/19/2034	04/30/2016	18
Shearon Harris Unit 1 (PWR)	10/24/2046	04/27/2009	37

Technical Basis for Duke's Request:

- The technical basis for Duke's Request for Alternative is contained in an EPRI Report
  - EPRI Report 3002014589, *Technical Basis for Optimization of the Volumetric Examination Frequency for Reactor Vessel Studs*. EPRI, Palo Alto, CA: November, 2018 (publicly available)
- This report is specific to Item No. B6.20 inspections for RPV studs, and includes the following:

  (1) Introduction
  - Describes the overall approach and provides the scope of the document and its applicability. Background is also provided for RPV studs

  (2) Degradation Mechanisms and Experience

  (3) Stress Analysis

  (4) Flaw Tolerance Assessment

  (5) Conclusions and Plant-Specific Applicability
- Brief summaries of Sections (2) through (5) of the report follow

(2) Degradation Mechanisms and Experience

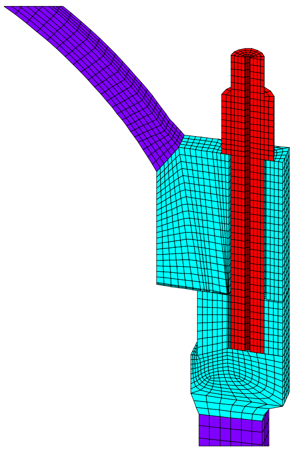
- Describes the literature review performed to identify degradation mechanisms that may contribute to RPV stud degradation and flaw propagation
  - Based on the 2007 expert panel on Proactive Materials Degradation, three degradation mechanisms were considered for RPV studs: erosion corrosion (steam cutting), fatigue, and stress corrosion cracking (SCC)
  - The most significant degradation issue was SCC due to Molykote lubricant combined with elevated strength of bolting materials
    - Maximum tensile strength for existing industry studs is generally less than 170 ksi
    - Procedurally prohibited Molykote lubricant decades ago
    - Generic Safety Issue 109 on RV Closure was resolved and closed by NRC
  - Stuck studs most prevalent OE – not considered applicable to degradation issues
- A description of current examination requirements is also provided
  - Requires volumetric examination every Interval
  - Surface examination may be substituted for volumetric when studs are removed
    - PWR studs are typically removed every outage
    - BWR studs are typically not removed every outage

(3) Stress Analysis (1/2)

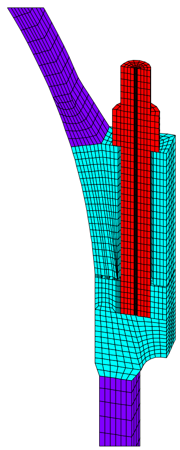
- Performed generic finite element analysis of the closure region including the closure head and flange, upper vessel and flange, and closure stud and nut/washer stack
- PWR and BWR models developed and evaluated separately
  - Substantial differences in diameter and thickness for RPV head in PWR vs BWR
  - These differences play a prominent role in stud bending stresses
- Models developed using inputs provided by utilities from industry survey
  - Combinations of model parameters were used to identify a single bounding configuration for each of the PWR and BWR geometries
  - The bounding model parameter was identified as the head shell radius-to-thickness ratio (R/t)
    - The maximum R/t was used along with the minimum stud shank diameter
  - One-stud circumferential slice of the RPV closure region was modeled
    - Conservatively simulates tensioning all studs at once – maximizes stud bending stress

(3) Stress Analysis (2/2)

PWR Model



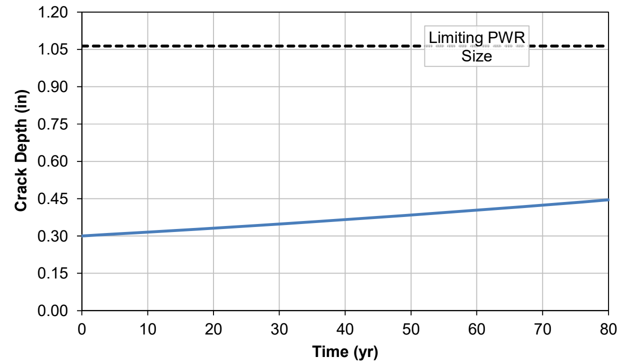
BWR Model

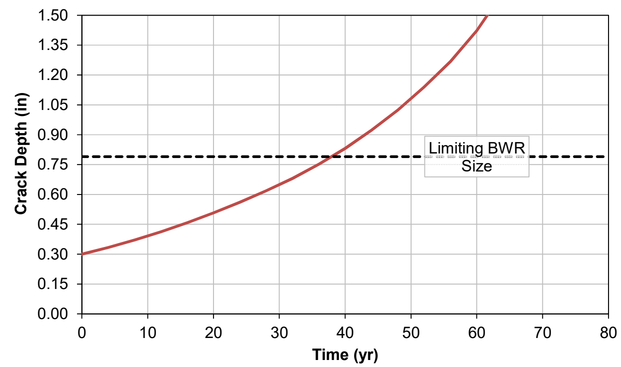


- Evaluated typical BWR and PWR RPV closure transients for peak stresses and maximum changes in stud stresses
  - PWR model transients/stress states
    - Preload, hydrotest, operation, heatup, cooldown, plant loading/unloading, small step increase/decrease, loss of load, loss of flow, reactor trip
  - BWR model transients/stress states:
    - Preload, hydrotest, operation, inner seal leakage, startup, shutdown, loss of feedwater pumps, preop blowdown

(4) Flaw Tolerance Assessment

- A deterministic flaw tolerance assessment was performed
  - No probabilistic evaluations were performed for this study; the results are based on bounding deterministic assessments
- Calculated allowable crack depths
- Calculated the projected fatigue crack growth for hypothetical initial fatigue cracks
- Computed the time for the final flaw sizes to reach the allowable flaw sizes
- The following results were calculated
  - PWR: 0.445" after 80 years < 1.06" maximum allowable
  - BWR: reaches 0.789“ maximum allowable after 37.9 years
- Therefore, PWR studs have 80 years of flaw tolerance, BWR studs have 38 years of flaw tolerance





(5) Conclusions and Plant-Specific Applicability

- This section of the report provides conclusions from the technical evaluations and 8 criteria that are to be met for the technical bases to be considered applicable on a plant-specific basis:
  1. The RPV head inner radius-to-head thickness ratio is smaller than 34.8 for BWRs and 14.5 for PWRs, which is the bounding ratio used in the underlying evaluation
  2. The RPV head shell inner radius-to-stud diameter ratio is smaller than 22.4 for BWRs and 14.0 for PWRs, which is the bounding ratio used in the underlying evaluation
  3. The applicable transients are bounded by the transients used in the EPRI report analysis
  4. The number of transients projected through the end of the applicable operating period is less than the number of transients used in the EPRI report analysis
  5. All RPV studs remain in service and are successfully tensioned
  6. All RPV studs are fabricated from material consistent with low susceptibility to SCC
  7. RPV studs are specified as SA-540, Grades B23 or B24 material, or the RPV stud material specification is consistent with all SA-540 Grade B23/B24 requirements
  8. No leakage from the RPV flange has been observed since the most recent volumetric/surface examination

V. Conclusion / Schedule

- **<u>Conclusions Regarding the EPRI Report for Duke's Request:</u>**
  - The plant-specific criteria for application of the EPRI report will be satisfied for all of the Duke plants included in the Request for Alternative
  - The requested inspection frequency extension is based on prior satisfactory inspection histories for all plants included in the request
  - The results of the EPRI generic flaw tolerance analyses conclude that the existing ASME Section XI inspection interval of 10 years can be extended to as much as 80 years from the last examination without compromising plant or public safety
  - Duke's Request for Alternative requests an extension for RPV stud examination to the end of the currently-licensed operating period for all plants included in the request
    - This extended time period ranges from 17 to 37 years, depending on the plant
    - These are generally a factor of 2 less than the periods established in the EPRI Report

V. Conclusion / Schedule

- Duke Energy is requesting an alternative to the examination requirements of ASME Section XI Table IWB-2500-1 (B-G-1), Examination Category B-G-1, Item B6.20. The request is for no further examinations of the studs for the remainder of the currently licensed 60 year operating periods.

- Request 1 year NRC review