TENNESSEE VALLEY AUTHORITY

1101 Market Street, Chattanooga, Tennessee 37402

CNL-23-044

June 1, 2023

10 CFR 50.4

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555 0001

Watts Bar Nuclear Plant, Unit 1
Facility Operating License No. NPF-90
NRC Docket No. 50-390

Subject: **Transmittal of Revision 3 to WCAP-18774-P and WCAP-18774-NP, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2" (EPID L-2023-LLA-0064)**

References:
1. TVA letter to NRC, CNL-23-043, "Watts Bar Nuclear Plant, Unit 1 – Emergency License Amendment Request to Relax the Required Number of Fully Tensioned Reactor Pressure Vessel Head Closure Studs in Technical Specification Table 1.1-1, 'MODES' (WBN-TS-23-09)," dated May 4, 2023 (ML23124A403 and ML23124A404)

2. NRC letter to TVA, "Watts Bar Nuclear Plant, Unit 1 - Issuance of Amendment No. 161 Regarding a One-Time Use Change to Footnotes Applicable to Technical Specification Table 1.1-1 'Modes' (Emergency Circumstances) (EPID L-2023-LLA-0064)," dated May 5, 2023 (ML23125A220)

In Reference 1, Tennessee Valley Authority (TVA) submitted a request for a one-time emergency license amendment request (LAR) to Facility Operating License No. NPF-90 for the Watts Bar Nuclear Plant (WBN), Unit 1, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.91(a)(5). Reference 1 was approved by the Nuclear Regulatory Commission (NRC) in Reference 2.

Enclosure 2 to Reference 1 contained Westinghouse Electric Company LLC (Westinghouse) WCAP-18774-P, Revision 1, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2." Due to the emergent nature of the Reference 1 LAR, Enclosure 2 to Reference 1 was submitted as a proprietary document in its entirety. However, as noted in Reference 1, TVA stated it would submit a revision of WCAP-18774-P with revised proprietary markings and an associated non-proprietary version within 30 days following NRC approval of the Reference 1 LAR.

Accordingly, Enclosure 1 to this submittal contains WCAP-18774-P, Revision 3, “Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2.” Enclosure 1 contains information that Westinghouse considers to be proprietary in nature pursuant to 10 CFR 2.390, "Public inspections, exemptions, requests for withholding," paragraph (a)(4). Enclosure 2 contains a non-proprietary version of Enclosure 1.

Enclosure 3 provides the Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-23-019 affidavit supporting this proprietary withholding request. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390. Accordingly, TVA requests that the information, which is proprietary to Westinghouse, be withheld from public disclosure in accordance with 10 CFR 2.390. Correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse affidavit should reference CAW-23-019 and should be addressed to Camille T. Zozula, Manager, Regulatory Compliance & Corporate Licensing.

There are no new regulatory commitments contained in this letter. Please address any questions regarding this submittal to Stuart L. Rymer, Senior Manager, Fleet Licensing, at slrymer@tva.gov.

Respectfully,

Digitally signed by Edmondson, Carla
Date: 2023.06.01 11:47:42 -04'00'

Kimberly D. Hulvey
Director, Nuclear Regulatory Affairs

Enclosures:

1. WCAP-18774-P, Revision 3 (Proprietary)
2. WCAP-18774-NP, Revision 3 (Non-Proprietary)
3. Westinghouse Electric Company LLC Application for Withholding Proprietary Information from Public Disclosure (Affidavit CAW-23-019)

cc: See Page 3

cc (Enclosures):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Watts Bar Nuclear Plant
NRC Project Manager – Watts Bar Nuclear Plant
Director, Division of Radiological Health – Tennessee State Department of Environment and Conservation

Enclosure 1

WCAP-18774-P, Revision 3 (Proprietary)

Proprietary Information – Withhold Under 10 CFR § 2.390

Enclosure 2

WCAP-18774-NP, Revision 3 (Non-Proprietary)

WCAP-18774-NP
Revision 3

May 2023

Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2

Westinghouse

WCAP-18774-NP
Revision 3

Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2

George J. Demetri *
Reactor Vessel / Containment Vessel Design and Analysis

May 2023

Reviewer: Stephan L. Abbott *
Reactor Vessel / Containment Vessel Design and Analysis

Approved: Lynn A. Patterson *, Manager
Reactor Vessel / Containment Vessel Design and Analysis

*Electronically approved records are authenticated in the electronic document management system.

Westinghouse Electric Company LLC
1000 Westinghouse Drive
Cranberry Township, PA 16066, USA

CERTIFICATION

I, the undersigned, being a Registered Professional Engineer competent in the applicable field of design and using the certified Design Specifications and the drawings identified below as a basis for design, do hereby certify that to the best of my knowledge and belief the Stress Report is complete and accurate and complies with the design requirements of the ASME Boiler and Pressure Vessel Code, Section III, 1971 Edition with Addenda through Winter 1971.

Design Specifications and Revisions:

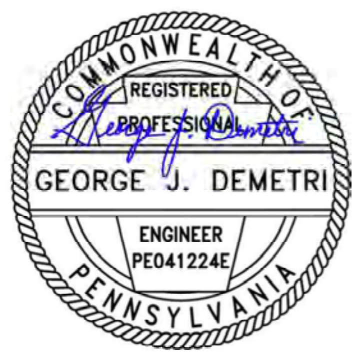
Unit 1	Unit 2
WAT-RCS-SP-CD-000001, Rev. 0 [30]	WBT-RCS-SP-CD-000001, Rev. 0 [32]
DS-SDA-20-1, Rev. 1 [33]	DS-SDA-20-1, Rev. 1 [33]
DS-MRCDA-16-1, Rev. 0 [2]	DS-MRCDA-09-6, Rev. 2 [31]
679005, Rev. 4 [12]	
676413, Rev. 2 [13]	

Drawings and Revision: N/A

Design Report and Revision: WCAP-18774-NP, Rev. 3

Certified by: George J. Demetri, Certifying Engineer

Date: Electronically Approved*



Registration No.: PE041224E State: PA

Expiration Date: 09/30/2023

*Electronically approved records are authenticated in the electronic document management system.

OWNER'S DESIGNEE CERTIFICATION STATEMENT

This Design Report has been reviewed by the undersigned in accordance with NA-3260 of the ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1971 Edition with Addenda up to and including Winter 1971, and to the best of the reviewer's knowledge and belief is based upon the Design, Service, and Test Loadings stated in the Design Specifications.

Design Specifications and Revisions:

Unit 1

WAT-RCS-SP-CD-000001, Revision 0 [30]
DS-SDA-20-1, Revision 1 [33]
DS-MRCDA-16-1, Revision 0 [2]
679005, Revision 4 [12]
676413, Revision 2 [13]

Unit 2

WBT-RCS-SP-CD-000001, Revision 0 [32]
DS-SDA-20-1, Revision 1 [33]
DS-MRCDA-09-6, Revision 2 [31]

Design Report and Revision: WCAP-18774-NP, Revision 3

Owner/Owner's Designee: Tennessee Valley Authority (TVA)/Westinghouse Electric Company LLC

Reviewer and Affiliation: Geoffrey M. Loy, Westinghouse Electric Company LLC
Signature/Date: Electronically Approved*

*Electronically approved records are authenticated in the electronic document management system.

ASME Code Design Report Owner's Designee Review Documentation

1. Identification of Design Report and/or Section:
   WCAP-18774-NP, Revision 3, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) – Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2"

2. Plant Applicability:
   Watts Bar Units 1 and 2

3. a. The applicable Design Specifications are:

   Unit 1

   Equipment Specifications 676413, Revision 2 [13] and Addendum 679005, Revision 4 [12], and Design Specification Addenda DS-MRCDA-16-1, Revision 0 [2], DS-SDA-20-1, Revision 1 [33] and WAT-RCS-SP-CD-000001, Revision 0 [30]

   Unit 2

   Design Specification DS-MRCDA-09-6, Revision 2 [31], and Design Specification Addenda DS-SDA-20-1, Revision 1 [33] and WBT-RCS-SP-CD-000001, Revision 0 [32]

   b. Do the Design Report Registered Professional Engineer and Owner's Designee (if applicable) Certification statements list the same Design Specification Number and Revision as in 3.a? <u>Yes</u> No

   c. If no, does the difference affect the applicability of the Design Report?
      Yes No

   d. If no, explain why not?

4. a. External loads are listed in the Design Report as follows:
   External loads were not revised for the one stud out of service evaluation and are therefore not listed in this addendum. Stud stresses from a previous analysis [3 and 14] were updated based on the increase in stress in the studs adjacent to the out-of-service stud. As a result, all

applicable loads used in the previous analyses of the studs were considered. Those loads were taken from the applicable design specifications ([2], [12], and [13]).

b. Do the loads used in the Design Report agree with those specified in the applicable Design Specification? Yes No

c. Has final load conformance been performed?

Yes No

d. If yes, list reference(s):

Final load conformance was previously performed in the analyses for Watts Bar Unit 1 [3 through 11, 14, 23, 25, and 26] and for Watts Bar Unit 2 [3 thru 8, 14, and 25 through 29].

e. If no, indicate action taken.

5. a. Load combinations used in the Design Report are defined in:

Stud stresses from a previous analysis [3 and 14] were updated based on the increase in stress in the studs adjacent to the out-of-service stud. As a result, all applicable load combinations used in the previous analysis of the studs were considered. Those load combinations were taken from the applicable design specification.

b. Do these load combinations agree with those specified in the Design Specification?

Yes* No

*Equipment Specification 676413, Revision 2 [13, Section 1.0] and Design Specification DS-MRCDA-09-6, Revision 2 [31, Section 1.0] require analysis in accordance with ASME Code, Section III, Subsection NB [1] which specifies the appropriate load combinations.

c. Stress limit criteria for load combinations used in stress analyses are defined in:

Stud stresses from a previous analysis [3 and 14] were updated based on the increase in stress in the studs adjacent to the out-of-service stud. As a result, all applicable stress limit criteria used in the previous analysis of the studs were considered. Those criteria were taken from the applicable design specification.

d. Do these stress limit criteria agree with the criteria in the Design Specification?

Yes* No

*Equipment Specification 676413, Revision 2 [13, Section 1.0] and Design Specification DS-MRCDA-09-6, Revision 2 [31, Section 1.0] require analysis in accordance with ASME Code, Section III, Subsection NB [1] which specifies the appropriate stress limit criteria.

6. a. Design and operating parameters used in the stress analyses are defined in:

Stud stresses from a previous analysis [3 and 14] were updated based on the increase in stress in the studs adjacent to the out-of-service stud. As a result, all applicable design and operating parameters used in the previous analysis of the studs were considered. Those parameters were taken from the applicable design specification.

b. Do these design and operating parameters agree with those specified in the Design Specification? Yes No

c. NSSS design transients used in the stress analyses are defined in:

Stud stresses from a previous analysis [3 and 14] were updated based on the increase in stress in the studs adjacent to the out-of-service stud. As a result, all applicable design transients used in the previous analysis of the studs were considered. Those transients were taken from the applicable design specification.

d. Do these NSSS design transients agree with those specified in the Design Specification?

Yes No

7. Has the Design Report been signed by a Professional Engineer for the certificate holder certifying that ASME Code requirements have been met? Yes No

8. a. Is the Design Report acceptable per ASME Code review as submitted?

Yes No

b. If no, identify basis of non-acceptance and action taken.

9. a. Have all the appropriate supporting calculations evaluating all Design Specification loadings been included in this Design Report?

Yes No

b. If no, please explain.

RECORD OF REVISIONS

Rev.	Date	Description
0-A	6/30/22	Draft issue for customer review and comment.
0	7/19/22	Original issue incorporating customer comments
1	8/25/22	Added discussion in Section 5.0 on stud tensioning and de-tensioning procedure changes and consideration of impact to 10 CFR 50, Appendix G P-T limit curves. Also added references in Section 6.0 for heatup and cooldown P-T limit curves for Unit 1 and Unit 2.
2	5/24/23	Added proprietary markings. Also removed internal verification checklists A-D in Appendices A and B. Revised document to revision 2. No other changes made.
3	See PRIME	Added checklists A-D back into Appendices A and B. Revised document to revision 3. No other changes made.

ABSTRACT

The structural integrity of the Watts Bar Unit 1 reactor vessel (RV), as established in Rotterdam Dockyard Company (RDM) Stress Report for Order No. 30749 [3 and 14], is reaffirmed by this addendum report, which supplements the following independently-certified addendum reports:

- Operating Parameter Change Evaluation [4]
- Excessive Feedwater Flow Transient Evaluation [5]
- Cold Overpressure Mitigation System (COMS) Transient Evaluation [6]
- 10% Steam Generator Tube Plugging (SGTP) Program [7]
- Optimized Stud Tensioning [8]
- Upper Head Injection (UHI) Elimination [9]
- Instrumentation Port Column Articu-Clamp Assembly [10]
- Core Support Block Updates [11]
- Out-of-Service Closure Stud Location #34 [24]
- Simplified Head Assembly [25]
- T_{avg} Reduction Program [26]

The structural integrity of the Watts Bar Unit 2 reactor vessel, as established in Rotterdam Dockyard Company Stress Report for Order No. 30750 [3 and 14], is reaffirmed by this addendum report, which supplements the following independently-certified addendum reports:

- Operating Parameter Change Evaluation [4]
- Excessive Feedwater Flow Transient Evaluation [5]
- Cold Overpressure Mitigation System (COMS) Transient Evaluation [6]
- 10% Steam Generator Tube Plugging (SGTP) Program [7]
- Optimized Stud Tensioning [8]
- Upper Head Injection (UHI) Elimination [27]
- Core Exit Thermocouple Elimination [28]

- Watts Bar Unit 2 Completion Project [29]
- Simplified Head Assembly [25]
- T_{avg} Reduction Program [26]

This report provides evaluations to justify power operation of the Watts Bar Unit 1 reactor vessel and the Watts Bar Unit 2 reactor vessel with one reactor vessel closure stud out-of-service for the 40-year design life. The effect of the load increase in the adjacent studs and the sealing ability of the reactor vessel O-rings when one stud is assumed out of service are evaluated.

Based on this evaluation, neither the function nor structural integrity of the Watts Bar Unit 1 or the Watts Bar Unit 2 reactor vessels and closure studs is compromised when either reactor vessel operates with one closure stud out of service provided the balance of the closure studs are properly tensioned in accordance with the tensioning procedure by which the one stud remains out of service.

All of the applicable requirements specified in Section III, Subarticle NB-3200 of the 1971 Edition of the ASME Boiler and Pressure Vessel Code with Addenda through the Winter of 1971 [1] are satisfied.

TABLE OF CONTENTS

1 INTRODUCTION

The closure studs are removed from the Watts Bar Unit 1 and Watts Bar Unit 2 reactor vessels following de-tensioning at the beginning of the refueling outage for the particular unit. When difficulty is encountered in turning a closure stud out of its vessel flange stud hole, the resistance to turning of the stud may become so great that the stud cannot be turned out of the hole. If the stud has been turned out of the hole to the extent that the required length of engagement between the stud and the stud hole threads, or if significant thread damage is suspected, the stud could be determined to be seized in a condition that does not permit it to be tensioned. It may be necessary to leave the stud in place and untensioned so that it can be removed during a subsequent outage after careful planning and preparation. Moreover, if the stud is completely turned out against resistance and removed, and significant stud hole thread damage is observed or suspected, as occurred for the Watts Bar Unit 1 stud hole at Location #34 in 2020 [24], the damage to the threads of the stud hole may not permit the stud to be re-inserted without extensive repair. Rather than extending the outage to repair the damage to the stud hole threads, it may be decided to resume operation with the stud at the location out of service until the thread damage can be carefully inspected and an informed repair can be performed during a subsequent outage.

Presented in this report are the analyses and evaluations necessary per [1] to substantiate the structural adequacy of the Watts Bar Unit 1 and Unit 2 reactor vessels for operation with one stud out of service for multiple fuel cycles up to the 40-year design life. The analyses and evaluations in this report evaluate the critical operating parameters, design transients, and design loads from [2], [12], [13], [30], [31], and [32] associated with operating the reactor vessels under that condition.

This addendum supplements the following Watts Bar Unit 1 reactor vessel stress reports:

- Rotterdam Dockyard Company Stress Report (for RDM Order 30749; applies to WAT reactor vessel) [3 and 14]
- Operating Parameter Change Evaluation [4]
- Excessive Feedwater Flow Transient Evaluation [5]
- COMS Transient Evaluation [6]
- 10% SGTP Program [7]
- Optimized Stud Tensioning [8]
- UHI Elimination [9]
- Instrumentation Port Column Articu-Clamp Assembly [10]
- Core Support Block Updates [11]
- Out-of-Service Closure Stud Location #34 [24]
- Simplified Head Assembly [25]
- T_{avg} Reduction Program [26]

This addendum supplements the following Watts Bar Unit 2 reactor vessel stress reports:

- Rotterdam Dockyard Company Stress Report (for RDM Order 30750; applies to WBT reactor vessel) [3 and 14]
- Operating Parameter Change Evaluation [4]
- Excessive Feedwater Flow Transient Evaluation [5]
- COMS Transient Evaluation [6]

- 10% SGTP Program [7]
- Optimized Stud Tensioning [8]
- UHI Elimination [27]
- Core Exit Thermocouple Elimination [28]
- Watts Bar Unit 2 Completion Project [29]
- Simplified Head Assembly [25]
- T_{avg} Reduction Program [26]

2 METHODS OF EVALUATION

The required lengths of closure stud thread engagement in the reactor vessel flange stud holes are calculated for both stud tensioning and normal operation based on the shear stress in the threads. The maximum load during stud tensioning due to the tensioner capacity and tensioning procedure is applied to the stud, and the required length of thread engagement to develop the necessary thread shear area to react the load is calculated. In the same manner, the maximum load on the studs during reactor operation from the reactor vessel stress reports is applied to the stud, and the length of thread engagement to react this maximum operational load is calculated. The design length of stud thread engagement in the stud hole threads is determined based on the design drawing geometry and the installation procedure. The required lengths of engagement with all 54 studs tensioned and with one stud out of service can then be compared to the design length of engagement.

To determine the effect of the out-of-service stud, the distribution of the forces (or strains) in the studs is defined using a method of extreme fiber stress determination in the irregularly shaped cross-section of the bolted flange structure. The method is similar to the method used to determine the bending stress in a beam cross-section with an applied end load. Using that distribution of forces, the increase in load in the two studs directly adjacent to the out-of-service stud and the corresponding average stud service stress and maximum stud service stress are determined. In addition, the increases in flange separation, required thread engagement, and bearing stress under the stud washer due to the out-of-service stud are calculated and checked against their corresponding limits to ensure they remain acceptable.

3 ACCEPTANCE CRITERIA

The following acceptance criteria were used in the evaluation of one stud out of service:

- The maximum stud average service stress shall be less than $2S_m$ at operating temperature in accordance with [1].
- The maximum stud service stress including bending shall be less than $3S_m$ at operating temperature in accordance with [1].
- The bearing stress in the closure head flange under the stud washers shall be less than S_y at operating temperature in accordance with [1].
- The reactor vessel flange separation at the O-rings must remain less than the minimum O-ring springback of 0.015 inch for Inconel 718 O-rings with a 0.455-inch tube cross-sectional diameter [15].
- The maximum cumulative fatigue usage factor for the closure studs shall be less than 1.0 in accordance with [1].
- The thread shear stress during stud tensioning and de-tensioning is limited to $0.4S_y$ in accordance with [16]. This limit is used to ultimately determine thread engagement.
- The thread shear stress during normal operation is limited to $0.6S_m$ in accordance with [1]. This limit is used to ultimately determine thread engagement.
- The calculated required length of thread engagement shall be less than the design length of thread engagement for each stud.

4 DESIGN INPUTS

The following design inputs were used in the evaluation of one stud out of service:

- The maximum tensioner pre-load on a stud was based on the stud tensioner capacity from [17], which is also applicable to Watts Bar Unit 1.
- The maximum operational pre-load was based on the condition at the end of plant heatup and is obtained from [3 and 14].
- The reactor vessel stud hole coordinates were obtained from [18].
- The stud and stud hole information was obtained from [19] and [21].
- Material information was obtained from [20].

5 SUMMARY OF RESULTS AND CONCLUSIONS

5.1 RESULTS

5.1.1 Stud Stresses and Fatigue Usage Factor

Calculation WATM-RV000-CN-CD-000002 [23], which is provided in Appendix B of this report, was performed in order to justify plant operation with one reactor vessel closure stud out of service. Reference [23] concluded that the loading on the two studs immediately adjacent to the stud that is out of service will increase by a maximum of [ ]^{a,c,e} As a result of the increased loading on these adjacent studs, the average stud service stress increases to a value of [ ]^{a,c,e} (or [ ]^{a,c,e} for deviated Unit 2 stud number 3 only), which is less than the allowable of $2S_m$, or 73.26 ksi, and the maximum stud service stress increases to a value of [ ]^{a,c,e}, which is less than the allowable of $3S_m$, or 109.9 ksi. A fatigue evaluation was performed in [23] to justify reactor operation with one reactor vessel stud out of service at any stud hole location in both the Watts Bar Unit 1 and Unit 2 reactor vessels for the 40-year design life. The maximum cumulative usage factor for the studs adjacent to the out-of-service stud location was conservatively calculated to be [ ]^{a,c,e}, which is less than the limit of 1.0.

5.1.2 Flange Separation

The flange separation at the O-ring gaskets was also evaluated in [23]. The increase in stud elongation in the studs directly adjacent to the out-of-service stud combined with the maximum gap of [ ]^{a,c,e}, results in a total flange separation of [ ]^{a,c,e}, which is less than the minimum O-ring springback of 0.015 inch for the current Watts Bar Unit 1 and Unit 2 O-rings.

5.1.3 Bearing Stress

Reference [23] also noted that the bearing stress under the washers of the two studs adjacent to the out-of-service stud exceeds the allowable bearing stress of 44.5 ksi when the maximum preload elongation tolerance in [8] is applied during reactor vessel stud tensioning. However, if the maximum stud preload is limited to [ ]^{a,c,e} in accordance with the original reactor vessel stud tensioning procedure, the maximum bearing stress under the washers is [ ]^{a,c,e}, which is less than the allowable of 44.5 ksi. Therefore, the studs adjacent to the out-of-service stud must be tensioned for a pre-load elongation not to exceed [ ]^{a,c,e} for the fuel cycles with the one stud out of service.

5.1.4 Thread Engagement

Calculation WATM-RV000-CN-CD-000001 [22], which is provided in Appendix A of this report, was performed in order to identify the excess thread engagement between the fully engaged studs and the stud holes based on the maximum allowable shear stress in the stud hole threads. The thread engagement required to react the maximum normal operation stud tensile load of 1,734.54 kips without exceeding the stud hole allowable shear stress is [ ]^{a,c,e} with all 54 studs tensioned, which is less than the design minimum thread engagement of [ ]^{a,c,e}. With one stud out of service, the thread engagement required to react the normal operation stud tensile load that corresponds to a pre-load elongation of [ ]^{a,c,e}, which is also less than the design minimum thread engagement of [ ]a,c,e. The required thread engagement of [ ]a,c,e for one stud out of service was calculated in [23] using the methodology and equations from [22].

5.1.5 Stud Tensioning and De-tensioning

The Watts Bar Unit 1 and Unit 2 stud tensioning and de-tensioning procedures must be modified such that the procedure(s) used with one stud out-of-service does not specify tensioning or de-tensioning of the out-of-service stud during any of the steps in the tensioning or de-tensioning sequence. Therefore, [

]a,c,e

In addition, during stud tensioning the stud preload elongation in the two studs adjacent to the out-of-service stud must be no greater than [ ]a,c,e in accordance with the original Watts Bar Unit 1 and Unit 2 stud tensioning procedures.

All of the other steps in the tensioning and de-tensioning sequences should be performed as usual without modification.

5.1.6 Consideration of 10 CFR 50 Appendix G P-T Limit Curves

The 10 CFR 50, Appendix G pressure-temperature (P-T) limit curve analyses for Watts Bar Unit 1 and Unit 2 in [34] and [35] [

]a,c,e

5.2 CONCLUSIONS

The maximum stresses in the adjacent studs, the bearing stress in the closure head flange, the sealing of the reactor vessel O-rings, and the required thread engagement remain acceptable when one stud is left out of service during reactor operation. All of the stress intensities and fatigue cumulative usage factors still satisfy the applicable limits of Section III of the 1971 Edition of the ASME Code with Addenda through Winter 1971 [1], which is the construction Code used to design the Watts Bar Unit 1 and Watts Bar Unit 2 reactor vessels.

6 REFERENCES

1. ASME Boiler & Pressure Vessel Code, Section III, “Nuclear Power Plant Components,” 1971 Edition of Mechanical Engineers, New York, NY.
2. Westinghouse Design Specification, DS-MRCDA-16-1, Rev. 0, “Design Specification for Watts Bar Unit 1 Reactor Vessel– Addendum to 676413, Rev. 2 and 679005, Rev. 4,” December 12, 2017.
3. Rotterdam Dockyard Company (RDM) Report, 30749-B-030, Rev. 3, "Final Stress Report," October 21, 1981.
4. Westinghouse Report, WAT/WBT-5142, Rev. 0, “Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Operating Parameter Change Evaluation),” February 15, 1984.
5. Westinghouse Report, WAT/WBT-5338, “Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Excessive Feedwater Flow Transient Evaluation),” December 22, 1983. (Archived in EDMS with a primary object name of WAT-5338.)
6. Westinghouse Report, MED-PCE-3963, Rev. 0, “TVA WAT/WBT Addendum to Analytical Report for Watts Bar I & II Station Tennessee Valley Utility Company Reactor Vessel,” October 1986.
7. Westinghouse Report, MSE-REME-0486, “Addendum to the Rotterdam Dockyard Company Stress Report for the Tennessee Valley Authority Watts Bar Units 1 and 2 Reactor Vessels (Watts Bar 10% SGTP Program – Reactor Vessel Evaluation),” October 16, 1996. (Archived in EDMS with primary object name MSE-REME-486.)
8. Dominion Engineering Report, R-3216-00-1, Rev. 0, “Reactor Vessel Tensioning Optimization Stress Report Watts Bar Nuclear Plants Units 1 and 2,” March 1, 2005.
9. Westinghouse Report, WCAP-11237, Rev. 0, “Tennessee Valley Authority Watts Bar Unit 1 (WAT) Reactor Vessel Upper Head Injection Pipe Cap Stress Analysis,” September 22, 1986.
10. Westinghouse Report, WNEP-9023, Rev. 0, “Specific Design Report for the Instrumentation Port Column Articu-Clamp Assembly Plant Applicability UNIT: Watts Bar Unit 1 (WAT),” June 29, 1990.
11. Westinghouse Report, WCAP-18207-P, Rev. 0, “Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) for Watts Bar Unit 1,” December 2017.
12. Westinghouse Equipment Specification, 679005, Rev. 4, "Addendum to Equipment Specification 676413, Rev. 2, Standard Four Loop Plant – Watts Bar Units 1 & 2," August 3, 1978.
13. Westinghouse Equipment Specification, 676413, Rev. 2, “Reactor Vessel,” November 19, 1969.
14. Rotterdam Dockyard Company (RDM) Report, 30749-B-004, Rev. 1, "Analysis of the Main Closure," May 14, 1980.
15. Westinghouse Certificate of Conformance, Westinghouse Repair and Automation Services Certificate of Conformance for Customer Order No. 00000160-01167, Tennessee Valley Authority Watts Bar Nuclear Power Plant, Part Number SR U-210168-1 N – Metal O-ring, Outer 0.455 Dia. Inconel 718 and Part Number SR U-210168-2 N – Metal O-ring, Inner 0.455 Dia. Inconel 718 (including Garlock Helicoflex Data Certification Package) [Archived in PRIME under *Object Name* “Certificate of Conformance” and *Title* “O-ring Metal Outer and Inner”].

16. Specification for the Design, Fabrication & Erection of Structural Steel for Buildings, 1963 Edition, American Institute of Steel Construction, New York, NY.

17. Biach Industries Instruction Manual, RVM-WBT-ST, Rev. 0, "Reactor Vessel Manual, 2,350,000 # Tensioner Model #2-5069, 7"-8N-2A Thread."

18. Rotterdam Dockyard Company (RDM) Drawing, 30738-1534, Sheet 2, Rev. A, "173" P.W.R. Vessel "Westinghouse" Upper Shell Assembly."

19. Rotterdam Dockyard Company (RDM) Drawing, 30738-1544, Rev. 0, "173" P.W.R. Vessel "Westinghouse" Stud, Nut, Washer and Details."

20. Rotterdam Dockyard Company (RDM) Drawing, 30738-1553, Rev. D, "173" P.W.R. Vessel "Westinghouse" List of Materials."

21. Rotterdam Dockyard Company (RDM) Drawing, 30738-1715, Rev. C, "173" P.W.R. Vessel "Westinghouse" – Vessel Assembly."

22. Westinghouse Calculation, WATM-RV000-CN-CD-000001, Rev. 0, "Watts Bar Units 1 and 2 Reactor Vessel Stud Thread Engagement Evaluation," July 15, 2022.

23. Westinghouse Calculation, WATM-RV000-CN-CD-000002, Rev. 0, "Watts Bar Unit 1 Reactor Vessel Closure Stud Out of Service Evaluation for 40 Years," July 15, 2022.

24. Westinghouse Report WCAP-18576-P, Rev. 0," Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of an Out-of-Service Closure Stud for Watts Bar Unit 1," September 2020.

25. Westinghouse Report, WCAP-18599-P, Rev. 0. "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA Units III & IV (Report No. 30749-B-030, Rev. 3) for Watts Bar Simplified Head Assemblies," October 2020.

26. Westinghouse Report, WCAP-18700-P, Rev. 0, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) for the Watts Bar Tavg Reduction Program," November 2021.

27. Westinghouse Report, WCAP-11105-P, Rev. 1, "Tennessee Valley Authority Watts Bar Unit 2 (WBT) Reactor Vessel Upper Head Injection Pipe Cap Stress Analysis," August 10, 2010.

28. Westinghouse Report, WCAP-17140-P, Rev. 1, "Watts Bar Unit 2 Core Exit Thermocouple Adapter Cap Evaluation Report," April 30, 2010.

29. Westinghouse Report, WCAP-17293-P, Rev. 1, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) for the Watts Bar Unit 2 Completion Project," October 2014.

30. Westinghouse Design Specification, WAT-RCS-SP-CD-000001, Rev. 0, "Reactor Vessel Design Specification for Watts Bar Unit 1 - Addendum to Specifications 676413, Rev. 2, 679005, Rev. 4, DS-MRCDA-16-1, Rev. 0, and DS-SDA-20-1, Rev. 1," October 4, 2021.

31. Westinghouse Design Specification, DS-MRCDA-09-6, Rev. 2, "Watts Bar Unit 2 Reactor Vessel Design Specification," February 24, 2013.

32. Westinghouse Design Specification, WBT-RCS-SP-CD-000001, Rev. 0 "Reactor Vessel Design Specification for Watts Bar Unit 2 - Addendum to Specifications DS-MRCDA-09-6, Rev. 2 and DS-SDA-20-1, Rev. 1," October 5, 2021.

33. Westinghouse Design Specification, DS-SDA-20-1, Rev. 1, "Reactor Vessel Design Specification for the Watts Bar Unit 1 and Unit 2 RVCH Lift Lug Load Updates – Addendum to Specifications 676413, Rev. 2, 679005, Rev. 4, DS-MRCDA-16-1, Rev. 0, and DS-MRCDA-09-6, Rev. 2," September 27, 2021.

34. Westinghouse Report, WCAP-16761-NP, Rev. 0, "Watts Bar Unit 1 Heatup and Cooldown Curves for Normal Operation," November 29, 2007.

35. Westinghouse Report, WCAP-17035-NP, Rev. 2, "Watts Bar Unit 2 Heatup and Cooldown Limit Curves for Normal Operation and PTLR Support Documentation," December 7, 2009.

APPENDIX A
WATM-RV000-CN-CD-000001, REV. 0

FORM NUMBER – F-GES-CMPP-PR-DD-000002-1 Rev. 1

DOCUMENT COVER SHEET

DOCUMENT NO.	REVISION	
WATM-RV000-CN-CD-000001	**0**	

PE SEAL (If required)

ALTERNATE DOCUMENT NUMBER:

TITLE: Watts Bar Units 1 and 2 Reactor Vessel Stud Thread Engagement Evaluation

ATTACHMENTS:

a,c,e

Signature Responsibility	Name	SIGNATURE / DATE (If processing electronic approval select option)
ORIGINATOR	George J. Demetri	**Electronically Approved*** **
Verifier	Stephan L. Abbott	**Electronically Approved*** **
Responsible Manager	Lynn A. Patterson	**Electronically Approved*** **

a,c,e

****Electronically approved records are authenticated in the electronic document management system.***

Calculation Note Number	Revision	Page
WATM-RV000-CN-CD-000001	0	2

Project	**Network/Activity**	**Releasable (Y/N) (See Checklist A)**	**Open Items (Y/N) (See Section 4.2)**
Watts Bar RV Stud Out of Service	167961/0010	Y	N

Scope Description

Originator/Author Name	**Originator/Author Scope**
George J. Demetri	All
Verifier Name	**Verifier Scope**
Stephan L. Abbott	All (Lead Verifier)
Manager Name	**Manager Scope**
Lynn A. Patterson	All

Record of Revisions

Rev.	Date	Revision Description
0-A	6/30/22	Draft Issue
0	See PRIME	Original Issue incorporating verifier's comments

Table of Contents

1.0 Background and Purpose

Reactor vessel stud and/or stud hole threads may be lost or be left disengaged due to conditions such as stuck studs or thread damage. The amount of excess thread engagement in the reactor vessel stud/stud hole design must be known in order to determine if a decrease in thread engagement can be tolerated. The thread engagement evaluation herein may be applied to stud holes in both the Watts Bar Unit 1 and the Watts Bar Unit 2 reactor vessel flanges.

This calculation is performed for the purpose of determining the depth of closure stud thread engagement that is required in the Tennessee Valley Authority (TVA) Watts Bar Unit 1 and Unit 2 reactor vessel flange stud holes in order to satisfy the applicable closure stud and flange stress limits during stud tensioning and plant operation.

This calculation note was created and verified in accordance with Westinghouse Level 2 Procedures W2-8.3-101 and W2-8.4-102.

2.0 Summary of Results and Conclusions

The maximum required length of engagement between the Watts Bar Unit 1 and Unit 2 reactor vessel studs and stud hole threads is calculated to be [ ]^{a,c,e} for normal operation. The design minimum length of engagement based on the design drawing dimensions is [ ]^{a,c,e} Therefore, [ ]^{a,c,e} of excess engagement, are present in the design.

Based upon the conservative evaluation herein, there remains sufficient excess thread engagement between the Watts Bar Unit 1 and Unit 2 reactor vessel studs and stud holes to ensure that the thread shear stress in the stud holes does not exceed the applicable ASME Section III limit of $0.6S_m$, even when [ ]^{a,c,e} of engagement are lost. This excess thread engagement can, therefore, accommodate [ ]^{a,c,e} lost to damage or disengagement for any stud location in either the Watts Bar Unit 1 or Watts Bar Unit 2 reactor vessels.

3.0 References

1. ASME Boiler & Pressure Vessel Code, Section III, "Nuclear Power Plant Components," 1971 Edition through Winter 1971 Addenda, American Society of Mechanical Engineers, New York, NY.
2. Specification for the Design, Fabrication & Erection of Structural Steel for Buildings, 1963 Edition, American Institute of Steel Construction, New York, NY.
3. Rotterdam Dockyard Instruction Manual, RVM-WAT, Rev. 0, "Reactor Vessel Instruction Manual WAT."
4. Rotterdam Dockyard Company (RDM) Drawing, 30738-1544, Rev. 0, "173" P.W.R. Vessel "Westinghouse" – Stud Nut Washer and Details."
5. Rotterdam Dockyard Company (RDM) Drawing, 30738-1715, Rev. C, "173" P.W.R. Vessel "Westinghouse" – Vessel Assembly."
6. Rotterdam Dockyard Company (RDM) Report, 30749-B-030, Rev. 3, "Final Stress Report," October 21, 1981.
7. Rotterdam Dockyard Company (RDM) Report, 30749-B-004, Rev. 1, "Analysis of the Main Closure," May 14, 1980.
8. Dominion Engineering Report, R-3216-00-1, Rev. 0, "Reactor Vessel Tensioning Optimization Stress Report Watts Bar Nuclear Plant Units 1 and 2," March 1, 2005.
9. Biach Industries Instruction Manual, RVM-WBT-ST, Rev. 0, "Reactor Vessel Manual, 2,350,000# Tensioner Model #2-5069, 7" - 8N-2A Thread," October 16, 2009.
10. Westinghouse Letter, LTR-MRCDA-11-40, Rev. 0, "Determination of Minimum Allowable Thread Engagement for Reactor Vessel Stud Holes at Watts Bar 2," March 11, 2011.
11. Rotterdam Dockyard Company (RDM) Drawing, 30738-1553, Rev. D, "173" P.W.R. Vessel "Westinghouse" – List of Materials."
12. Rotterdam Dockyard Instruction Manual, RVM-WBT, Rev. 1, "Reactor Vessel Instruction Manual WBT."
13. Westinghouse Calculation Note, CN-SDA-20-14, Rev. 0, "Watts Bar Unit 1 Reactor Vessel Stud Thread Engagement Evaluation," May 2020.
14. Westinghouse Report, WCAP-17293-P, Rev. 1, "Addendum to Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) for the Watts Bar Unit 2 Completion Project," October 2014.

4.0 Calculations

4.1 Limits of Applicability

This calculation note is applicable to the Watts Bar Units 1 and 2 reactor vessels.

4.2 Open Items

There are no open items in this calculation note.

4.3 Method Discussion

The required lengths of closure stud thread engagement in the reactor vessel flange stud holes is calculated for both stud tensioning and normal operation based upon the shear stress in the threads. The maximum load during stud tensioning due to the tensioner capacity and tensioning procedure is applied to the stud, and the required length of thread engagement to develop the necessary thread shear area to react the load is calculated. In the same manner, the maximum load on the studs during reactor operation from the reactor vessel stress reports is applied to the stud, and the length of thread engagement to react this maximum operational load is calculated. The design length of stud thread engagement in the stud hole threads is then determined based upon the design drawing geometry and the installation procedure, and the required lengths of engagement are compared to the design length of engagement. The minimum difference between the required and design lengths of engagement is then identified as the excess thread engagement. The excess thread engagement is the number of threads which could be completely lost with no detriment to the structural integrity of the reactor vessel stud and stud hole.

a,c,e

[ ]a,c,e

4.5 Acceptance Criteria

1. The thread shear stress during stud tensioning and de-tensioning is limited to $0.4S_y$ in accordance with the AISC manual [2].

2. The thread shear stress during normal operation is limited to $0.6S_m$ in accordance with ASME Section III [1].

3. The calculated required length of thread engagement is less than the design length of thread engagement for each stud.

4.6 Input

The maximum tensioner tensile load on a stud is based upon the stud tensioner capacity from the stud tensioner manual [9]. The maximum operational tensile load on a stud is obtained from the Watts Bar Unit 1 and Unit 2 reactor vessel stress reports [6, 7, and 14]. The maximum operational tensile load is usually found to occur at the end of plant heatup.

[

]a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

[ ]^{a,c,e}

5.5 Conclusions

The maximum required length of engagement is based on the evaluation of shear stress in the stud hole threads during the heatup condition. That evaluation results in the lowest excess thread engagement which could be lost [ ]^{a,c,e} while still maintaining the required length of engagement. Again, as described in Section 5.3, this is based on the [ ]^{a,c,e} design engagement length, which considers the [ ]^{a,c,e} of bottom stud hole threads that do not engage with the stud threads. For [ ]^{a,c,e} threads per inch, [ ]^{a,c,e} of engagement length is equivalent to [ ]^{a,c,e}. Therefore, for the heatup condition, [ ]^{a,c,e} could be lost in the stud hole and the stud hole threads would still meet the minimum design requirements.

[ ]a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

APPENDIX B
WATM-RV000-CN-CD-000002, REV. 0

FORM NUMBER – F-GES-CMPP-PR-DD-000002-1 Rev. 1

DOCUMENT COVER SHEET

DOCUMENT NO.	REVISION	
WATM-RV000-CN-CD-000002	**0**	PAGE 1 of 28

PE SEAL (If required)

ALTERNATE DOCUMENT NUMBER: N/A

TITLE: Watts Bar Units 1 and 2 Reactor Vessel Stud Out of Service Evaluation for 40 Years

ATTACHMENTS:

a,c,e

Signature Responsibility	Name	SIGNATURE / DATE(If processing electronic approval select option)
ORIGINATOR	George J. Demetri	**Electronically Approved*** **
Verifier	Stephan L Abbott	**Electronically Approved*** **
Responsible Manager	Lynn A. Patterson	**Electronically Approved*** **

a,c,e

*****Electronically approved records are authenticated in the electronic document management system.***

Word Version 7.0

Calculation Note Number	Revision	Page
WATM-RV000-CN-CD-000002	0	2

Project	**Network/Activity**	**Releasable (Y/N) (See Checklist A)**	**Open Items (Y/N) (See Section 4.2)**
Watts Bar RV Stud Out of Service	167961/0010	Y	N

Scope Description

Originator/Author Name	**Originator/Author Scope**
George J. Demetri	All
Verifier Name	**Verifier Scope**
Stephan L. Abbott	All (Lead Verifier)
Manager Name	**Manager Scope**
Lynn A. Patterson	All

Record of Revisions

Rev.	Date	Revision Description
0-A	6/30/22	Draft Issue
0	See PRIME	Original Issue incorporating verifier's comments

Table of Contents

1.0 Background and Purpose

Reactor vessel closure studs sometimes seize in their reactor vessel stud holes when the studs are being turned in or out during an outage. When a stud is turned out of its stud hole too far or when substantial thread damage is suspected in the stud/stud hole thread engagement, tensioning of the stud for reactor operation during the subsequent fuel cycle might not be possible or practical. Therefore, the condition could necessitate the stud being left un-tensioned and out of service during power operation. This evaluation is required to justify reactor operation with only 53 studs fully tensioned and with one stud hole location out of service with no stud load acting at that location.

This calculation is performed for the purpose of evaluating the structural and functional effects in the reactor vessel main closure flange region resulting from one closure stud being left out of service. The calculation evaluates an increase in stress in the studs adjacent to the out-of-service stud location. In addition, the calculation evaluates the sealing of the reactor vessel O-rings at the azimuthal location of the out-of-service stud.

This calculation note was created and verified in accordance with Westinghouse Level 2 Procedures W2-8.3-101 and W2-8.4-102.

2.0 Summary of Results and Conclusions

With one stud out of service: (1) the maximum tensile stress in the adjacent studs is increased by [ ]^{a,c,e} for the as-designed studs and [ ]^{a,c,e} for the deviated Unit 2 stud number 3, which are less than the allowable of 73.26 ksi; (2) the maximum service stress in the adjacent studs is increased to [ ]^{a,c,e} for the as-designed studs and [ ]^{a,c,e} for the deviated stud, which are less than the allowable of 109.9 ksi; and (3) the maximum calculated gap at the inner O-ring is [ ]^{a,c,e}, which is less than the minimum O-ring springback of 0.015 inch (i.e., the O-rings will seal).

It is noted that the bearing stress under the washers of the two studs adjacent to the out-of-service stud exceeds the allowable bearing stress of 44.5 ksi when the maximum preload elongation tolerance in [3] is applied during reactor vessel stud tensioning. However, if the maximum stud preload elongation is limited to [ ]^{a,c,e} in accordance with the original reactor vessel stud tensioning procedure, the maximum bearing stress under the washers is [ ]^{a,c,e}, which is less than the allowable of 44.5 ksi. Therefore, the studs adjacent to the out-of-service stud must be tensioned to a preload elongation not to exceed [ ]^{a,c,e} for the fuel cycles with the one stud out of service.

The maximum cumulative fatigue usage factor (CUF) for the studs adjacent to the out-of-service stud is conservatively calculated to be [ ]^{a,c,e} considering the transient cycles for the 40-year design life and deviated Unit 2 stud number 3.

Conclusion

The maximum stresses in the adjacent studs, the bearing stress in the closure head flange, and the sealing of the reactor vessel O-rings remain acceptable when one stud is left out of service during reactor operation. All of the stress intensities still satisfy the applicable limits of Section III of the 1971 Edition of the ASME Code with Addenda through Winter 1971 [1], which is the construction Code used to design the Watts Bar Unit 1 and Unit 2 reactor vessels. The CUF less than 1.0 for the studs adjacent to the out-of-service stud permits the plant to operate for the remainder of the 40-year design life with one stud out of service to allow adequate time for contingencies regarding stud hole repair preparation and implementation.

3.0 References

1. ASME Boiler and Pressure Vessel Code, Section III, "Nuclear Power Plant Components," 1971 Edition through Winter 1971 Addenda, American Society of Mechanical Engineers, New York, NY.
2. Rotterdam Dockyard Company (RDM) Report, 30749-B-030, Rev. 3, "Final Stress Report," October 21, 1981.
3. Dominion Engineering, Inc. (DEI) Report, R-3216-00-1, Rev. 0, "Reactor Vessel Tensioning Optimization Stress Report Watts Bar Nuclear Plant Units 1 and 2," March 1, 2005.
4. Rotterdam Dockyard Company (RDM) Report, 30749-B-004, Rev. 1, "Analysis of Main Closure," May 14, 1980.
5. Westinghouse Calculation Note, WATM-RV000-CN-CD-000001, Rev. 0, "Watts Bar Units 1 and 2 Reactor Vessel Stud Thread Engagement Evaluation," July 15, 2022.
6. Rotterdam Dockyard Company (RDM) Drawing, 30738-1534, Sheet 2, Rev. A, "173″ P.W.R. Vessel "Westinghouse" Upper Shell Assembly."
7. Rotterdam Dockyard Company (RDM) Drawing, 30738-1544, Rev. 0, "173″ P.W.R. Vessel "Westinghouse" - Stud, Nut, Washer and Details."
8. Rotterdam Dockyard Company (RDM) Drawing, 30738-1553, Rev. D, "173″ P.W.R. Vessel "Westinghouse" - List of Materials."
9. Biach Industries Instruction Manual, RVM-WBT-ST, Rev. 0, "Reactor Vessel Manual, 2,350,000# Tensioner Model #2-5069, 7" - 8N-2A Thread," October 16, 2009.
10. Rotterdam Dockyard Company (RDM) Drawing, 30738-1715, Rev. C, "173″ P.W.R. Vessel "Westinghouse" – Vessel Assembly."
11. Rotterdam Dockyard Company (RDM) Drawing, 30738-1535, Rev. F, "173″ P.W.R. Vessel "Westinghouse" Closure Head Sub-Assembly."
12. Rotterdam Dockyard Company (RDM) Drawing, 30738-1534, Sheet 1, Rev. G, "173″ P.W.R. Vessel "Westinghouse" Upper Shell Assembly."
13. Westinghouse Certificate of Conformance, Westinghouse Repair and Automation Services Certificate of Conformance for Customer Order No. 00000160-01167, Tennessee Valley Authority Watts Bar Nuclear Power Plant, Part Number SR U-210168-1 N – Metal O-ring, Outer 0.455 Dia. Inconel 718 and Part Number SR U-210168-2 N – Metal O-ring, Inner 0.455 Dia. Inconel 718 (including Garlock Helicoflex Data Certification Package).
14. Rotterdam Dockyard Company (RDM) Report, 30750-B-051, Rev. 3, "Analytical Justification of the Stud with Diminished Diameter," November 1980.
15. Westinghouse Report, WCAP-17293-P, Rev. 1, "Addendum to Rotterdam Dockyard Company Final Stress Report for 173″ P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) for the Watts Bar Unit 2 Completion Project," October 2014.
16. Westinghouse Calculation Note, CN-MRCDA-11-3, Rev. 0, "Watts Bar 2 – Reactor Vessel Structural Analysis Updates," November 2011.

17. Westinghouse Letter, LTR-MRCDA-13-98, Rev. 0, "Impact of Recent Watts Bar Unit 2 Reactor Vessel Structural Evaluations on Westinghouse Calculation Note CN-MRCDA-11-3, Rev. 0," December 2013.

18. Westinghouse Report, WCAP-18700-P, Rev. 0, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) for Watts Bar T_{avg} Reduction Program," November 2021.

4.0 Calculations

4.1 Limits of Applicability

This calculation note is applicable to Watts Bar Unit 1 and Unit 2 for reactor operation with one reactor vessel closure stud out of service for the remainder of the 40-year design life. The evaluation herein justifies operation with one out-of-service stud at any stud hole location for both the Unit 1 and Unit 2 reactor vessels.

4.2 Open Items

There are no open items in this calculation note.

4.3 Method Discussion

The distribution of the forces (or strains) in the studs will be defined using a method of extreme fiber stress determination in the irregularly shaped cross-section of the bolted flange structure. The method is similar to the method used to determine the bending stress in a beam cross-section with an applied end load.

4.4 Discussion of Assumptions

There are no significant assumptions in this calculation note.

4.5 Acceptance Criteria

1. The maximum stud average service stress shall be less than $2S_m$ at operating temperature.

2. The maximum stud service stress including bending shall be less than $3S_m$ at operating temperature.

3. The bearing stress in the closure head flange under the stud washers shall be less than S_y at operating temperature.

4. The reactor vessel flange separation at the O-rings must remain less than the minimum O-ring springback of 0.015 inch for Inconel 718 O-rings with a 0.455-inch tube cross-sectional diameter [13].

5. The maximum cumulative fatigue usage factor for the closure studs shall be less than 1.0.

4.6 Input

The reactor vessel stud hole coordinates and stud and stud hole data are obtained from Rotterdam Dockyard Company Drawings [6], [7] and [12] for Watts Bar Unit 1 and Unit 2. The stud service stresses are obtained from the reactor vessel stress reports [2, 3, 4, 14, 15, 16 and 18]. The thread engagement information is obtained from [5].

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

[ ]a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

a,c,e

Calculation Note Number	Revision	Page
WATM-RV000-CN-CD-000002	0	27

a,c,e

Calculation Note Number	Revision	Page
WATM-RV000-CN-CD-000002	0	28

a,c,e

APPENDIX C
SUMMARY DESIGN REPORT CHECKLIST

Summary Design Report and As-Built Reconciliation Review Checklist

Westinghouse Proprietary Class 2

a,c,e

a,c,e

Enclosure 3

Westinghouse Electric Company LLC Application for Withholding Proprietary Information from Public Disclosure (Affidavit CAW-23-019)

Commonwealth of Pennsylvania:
County of Butler:

(1) I, Zachary Harper, Manager, Licensing Engineering, have been specifically delegated and authorized to apply for withholding and execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse).

(2) I am requesting the proprietary portions of WCAP-18774-P, Revision 3, "Addendum to the Rotterdam Dockyard Company Final Stress Report for 173" P.W.R. Vessels TVA III & IV (Report No. 30749-B-030, Rev. 3) - Evaluation of One Closure Stud Out of Service for 40 Years for Watts Bar Units 1 and 2," be withheld from public disclosure under 10 CFR 2.390.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

   (i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse and is not customarily disclosed to the public.

   (ii) The information sought to be withheld is being transmitted to the Commission in confidence and, to Westinghouse's knowledge, is not available in public sources.

   (iii) Westinghouse notes that a showing of substantial harm is no longer an applicable criterion for analyzing whether a document should be withheld from public disclosure. Nevertheless, public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

(5) Westinghouse has policies in place to identify proprietary information. Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(6) The attached documents are bracketed and marked to indicate the bases for withholding. The justification for withholding is indicated in both versions by means of lower-case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower-case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (5)(a) through (f) of this Affidavit.

I declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief. I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 5/31/2023

Signed electronically by
Zachary Harper