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Note: Enclosure 1 to this letter contains proprietary information.

Docket Number 50-346

License Number NPF-3

Serial Number 2705

May 22, 2001

United States Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555-0001

Subject: License Amendment Application to Revise Technical Specification 3/4.4.5, Steam Generators, Regarding Steam Generator Tube Repair Roll Requirements (License Amendment Request 01-0004)

Ladies and Gentlemen:

Enclosed is an application for an amendment to the Davis-Besse Nuclear Power Station (DBNPS), Unit Number 1, Operating License Number NPF-3, Appendix A, Technical Specifications. The proposed changes involve Technical Specification 3/4.4.5, Steam Generators, and its associated Bases section.

The proposed changes would revise the once-through steam generator (OTSG) tube repair roll requirements to 1) utilize updated limiting tensile tube loads, 2) define new exclusion zones within the steam generator in which the application of the repair roll is prohibited, 3) allow the repair roll to be used in the lower tubesheet area, 4) remove the limitation of only one repair roll per OTSG tube, and 5) replace the requirement that the repair roll be one inch in length with a requirement that the repair roll be installed in accordance with the enclosed proprietary Framatome Technologies Incorporated Topical Report BAW-2303P, Revision 4, "OTSG Repair Roll Qualification Report."

By letter dated March 12, 2001, the Babcock and Wilcox Owners' Group (BWOG), of which the DBNPS is a member, submitted to the NRC Topical Report BAW-2374, Revision 1, *Risk-Informed Assessment of Once-Through Steam Generator Tube Thermal Loads Due to Breaks in Reactor Coolant System Upper Hot Leg Large-Bore Piping*. BAW-2374, Revision 1, demonstrates the low risk associated with an upper hot leg large-bore pipe break and provides for the acceptability of basing OTSG thermal loads on the previously analyzed limiting accidents, which are a loss of coolant accident (LOCA) in reactor coolant system (RCS) attached pipes (pressurizer surge line and continuous reactor head vent line) and a main steam line break (MSLB). Consistent with Topical Report BAW-2374, Revision 1, this license amendment application utilizes a LOCA in RCS attached pipes and a MSLB as the limiting accidents for

A001

OTSG tube loads.

The DBNPS thirteenth refueling outage is presently scheduled to commence in March 2002, which will include inservice inspection of the OTSGs. The FirstEnergy Nuclear Operating Company (FENOC) requests NRC approval of this OTSG repair method so that it may be available for use, should it be needed. Accordingly, FENOC requests that the NRC approve and issue these TS changes by January 31, 2002, for implementation within 120 days after the NRC issuance of the License Amendment.

Should you have any questions or require additional information, please contact Mr. David H. Lockwood, Manager - Regulatory Affairs, at (419) 321-8450.

Very truly yours,

MAR/s

Enclosures

cc: J. E. Dyer, Regional Administrator, NRC Region III
S. P. Sands, NRC/NRR Project Manager
D. J. Shipley, Executive Director, Ohio Emergency Management Agency, State of Ohio (NRC Liaison)
K. S. Zellers, NRC Region III, DB-1 Senior Resident Inspector
Utility Radiological Safety Board

APPLICATION FOR AMENDMENT

TO

FACILITY OPERATING LICENSE NUMBER NPF-3

DAVIS-BESSE NCLEAR POWER STATION

UNIT NUMBER 1

Attached are the requested changes to the Davis-Besse Nuclear Power Station, Unit Number 1, Facility Operating License Number NPF-3. Also included is the Safety Assessment and Significant Hazards Consideration.

The proposed changes (submitted under cover letter Serial Number 2705) concern:

Appendix A, Technical Specifications:

3/4.4.5, Steam Generators, and associated Bases

I, Guy G. Campbell, state that (1) I am Vice President - Nuclear of the FirstEnergy Nuclear Operating Company, (2) I am duly authorized to execute and file this certification on behalf of the Toledo Edison Company and The Cleveland Electric Illuminating Company, and (3) the statements set forth herein are true and correct to the best of my knowledge, information, and belief.

By: ______________________________
Guy G. Campbell, Vice President - Nuclear

Affirmed and subscribed before me this 22nd day of May, 2001

____
Notary Public, State of Ohio - Nora L. Flood
My Commission expires September 4, 2002.

The following is provided to support issuance of the requested changes to the Davis-Besse Nuclear Power Station (DBNPS), Unit Number 1, Operating License Number NPF-3, Appendix A, Technical Specification 3/4.4.5, Steam Generators, and associated Bases.

A. Time Required to Implement: This change is to be implemented within 120 days after the NRC issuance of the License Amendment.

B. Reason for Change (License Amendment Request 01-0004):

The proposed changes would revise the once-through steam generator (OTSG) tube repair roll requirements to 1) utilize updated limiting tensile tube loads, 2) define new exclusion zones within the steam generator in which the application of the repair roll is prohibited, 3) allow the repair roll to be used in the lower tubesheet area, 4) remove the limitation of only one repair roll per OTSG tube, and 5) replace the requirement that the repair roll be one inch in length with a requirement that the repair roll be installed in accordance with Framatome Technologies Incorporated Topical Report BAW-2303P, Revision 4.

C. Safety Assessment and Significant Hazards Consideration: See Attachment 1.

D. Environmental Evaluation: See Attachment 2.

Enclosure Contents

- Enclosure 1 — Application for Amendment

  Attachment 1: Safety Assessment and Significant Hazards Consideration

  - Attachment 1 – Marked up Technical Specification Changes
  - Attachment 2 – Proprietary Topical Report BAW-2303P, Revision 4
  - Attachment 3 – Non-Proprietary Topical Report BAW-2303NP, Revision 4

  Attachment 2: Environmental Evaluation

- Enclosure 2 — Proposed Technical Specification Changes Revision Bar Format
- Enclosure 3 — Commitment List

Docket Number 50-346
License Number NPF-3
Serial Number 2705
Attachment 1

SAFETY ASSESSMENT AND SIGNIFICANT HAZARDS CONSIDERATION
FOR
LICENSE AMENDMENT REQUEST NO. 01-0004

(24 Pages Follow)

SAFETY ASSESSMENT AND SIGNIFICANT HAZARDS CONSIDERATION FOR LICENSE AMENDMENT REQUEST NUMBER 01-0004

TITLE:

Proposed Change to Technical Specification 3/4.4.5, Steam Generators, to Revise Steam Generator Tube Repair Roll Requirements

DESCRIPTION:

The Davis-Besse Nuclear Power Station (DBNPS) has two Once-Through Steam Generators (OTSGs) that were manufactured by Babcock and Wilcox. The OTSG tubes were fabricated from Inconel Alloy 600 material and were restrained by roll expansion joints in the upper and lower tubesheets. The original tube-to-tubesheet rolls were expanded by a hard roll process during the OTSG fabrication and are about 1 to 2 inches in axial length, expanded into the tubesheet. These tube-to-tubesheet rolls hold the tubes axially in the tubesheet. Each tubesheet is about 24 inches thick and a tube seal weld is provided at the primary face of the tubesheet to prevent leakage from the primary to secondary systems (see attached figure).

It is desirable to repair degraded OTSG tubes, if possible, and retain the tubes in service for providing heat transfer, rather than plugging the tubes and removing them from service. The current DBNPS Technical Specification (TS) 3/4.4.5, Steam Generators, Surveillance Requirement (SR) 4.4.5.4.a.7 allows "rolling" as a repair method for OTSG tubes. Tube repair rolling is a repair process for OTSG degraded tubes only when the degradation is located in the tube within the tubesheet. This process creates a new pressure boundary at the repair roll joint by roll expanding a new mechanical tube-to-tubesheet joint between the region of tube defects in the tubesheet and the secondary face of the tubesheet. The new pressure boundary removes the degraded area from pressure boundary service (see attached figure). Under the current DBNPS TS requirements, the OTSG tubes with defects only in the upper tubesheet area may be repaired by performing a single one inch long tube roll expansion (single roll) in accordance with Framatome Technologies Incorporated (FTI) Topical Report BAW-2303P, Revision 3, "OTSG Repair Roll Qualification Report," dated October 1997, (previously submitted to the NRC by DBNPS Letter Serial No. 2512, dated February 26, 1998).

The purpose of this License Amendment Request is to update the DBNPS Operating License NPF-3, Appendix A, Technical Specifications, regarding requirements for repair rolling OTSG tubes. The TS would be revised to reference attached Framatome Technologies Incorporated (FTI) Topical Report BAW-2303P, Revision 4, *OTSG Repair Roll Qualification Report,* as the basis for repair roll requirements. Topical Report BAW-2303P, Revision 4, supercedes Topical Report BAW-2303P, Revision 3. This License Amendment Request would revise existing OTSG repair roll requirements to 1) utilize updated limiting tensile tube loads, 2) define new exclusion zones within the steam generator in which the application of the repair roll is prohibited, 3) allow the repair roll to be used in the lower tubesheet area, 4) remove the limitation of only one repair roll per OTSG tube, and 5) replace the requirement that the repair roll be one inch in length with a requirement that the repair roll be installed in accordance with

Topical Report BAW-2303P, Revision 4. In addition, the name "Babcock and Wilcox" would be removed as an administrative change to TS SR 4.4.5.4.a.7 since Framatome ANP has succeeded the Babcock and Wilcox Company.

Existing TS SR 4.4.5.4.a.7 states:

> Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or repaired by repair roll or sleeving in the affected area because it may become unserviceable prior to the next inspection and is equal to 40% of the nominal tube wall thickness. The Babcock and Wilcox process described in Topical Report BAW-2120P will be used for sleeving. The repair roll process will only be used to repair tubes with defects in the upper tubesheet area. The repair roll process will be performed only once per steam generator tube using a 1 inch reroll length. The new roll area must be free of degradation in order for the repair to be considered acceptable. The repair roll process used is described in the Topical Report BAW-2303P, Revision 3.

The proposed change would revise TS SR 4.4.5.4.a.7 to state:

> Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or repaired by repair roll or sleeving in the affected area because it may become unserviceable prior to the next inspection and is equal to 40% of the nominal tube wall thickness. The process described in Topical Report BAW-2120P will be used for sleeving. The repair roll process used is described in the Topical Report BAW-2303P, Revision 4. The new roll area must be free of imperfections and degradation in order for the repair to be considered acceptable.

Existing TS SR 4.4.5.4.a.9 states:

> Tube Inspection means an inspection of the steam generator tube from the point of entry completely to the point of exit. The previously existing tube and tube roll, above the new roll area in the upper tube sheet, can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed.

TS SR 4.4.5.4.a.9 would be revised to state:

> Tube Inspection means an inspection of the steam generator tube from the point of entry completely to the point of exit. The previously existing tube and tube roll, outboard of the new roll area in the tube sheet, can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed.

The existing TS Bases 3/4.4.5 states, in part:

> An additional repair method for degraded steam generator tubes consists of rerolling the tubes in the upper tubesheet to create a new roll area and pressure boundary for the tube.

The repair roll process will ensure that the area of degradation will not serve as a pressure boundary, thus permitting the tube to remain in service. The degraded area of the tube can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed in the upper tubesheet.

All tubes which have been repaired using the repair roll process will have the new roll area inspected during the inservice inspection. Defective or degraded tube indications found in the new roll area as a result of the inspection of the repair roll and any indications found in the originally rolled region of the rerolled tube need not be included in determining the Inspection Results Category for the general steam generator inspection.

The repair roll process will be performed only once per steam generator tube using a 1 inch reroll length as described in the Topical Report BAW-2303P, Revision 3. Thus, multiple applications of the rerolling process to any individual tube is not acceptable. The new roll area must be free of degradation in order for the repair to be considered acceptable. After the new roll area is initially deemed acceptable, future degradation in the new roll area will be analyzed to determine if the tube is defective and needs to be removed from service. The rerolling process is described in the Topical Report BAW-2303P, Revision 3.

This TS Bases 3/4.4.5 part would be revised to state:

An additional repair method for degraded steam generator tubes consists of rerolling the tubes in the tubesheet to create a new roll area and pressure boundary for the tube. The repair roll process will ensure that the area of degradation will not serve as a pressure boundary, thus permitting the tube to remain in service. The degraded area of the tube can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed in the tubesheet.

All tubes which have been repaired using the repair roll process will have the new roll area inspected during the inservice inspection. Defective or degraded tube indications found in the new roll area as a result of the inspection of the repair roll and any indications found in the originally rolled region of the rerolled tube need not be included in determining the Inspection Results Category for the general steam generator inspection.

The repair roll process will be performed as described in the Topical Report BAW-2303P, Revision 4. The new roll area must be free of degradation in order for the repair to be considered acceptable. After the new roll area is initially deemed acceptable, future degradation in the new roll area will be analyzed to determine if the tube is defective and needs to be removed from service. Leakage from repair rolls will be accounted for to ensure post-accident primary-to-secondary leakage will not exceed that assumed in the safety analyses.

The use of BAW-2303P, Revision 4, has been previously reviewed by the NRC in approving License Amendment No. 318 to Facility Operating License Nos. DPR-38, DPR-47, and DPR-55 for the Oconee Nuclear Station, Units 1, 2, and 3, dated December 15, 2000 (TAC Nos. MA9969, MA9970, and MA9971), and License Amendment No. 212 to Facility Operating License No. DPR-51 for Arkansas Nuclear One, Unit 1, dated March 28, 2001.

SYSTEMS, COMPONENTS, AND ACTIVITIES AFFECTED:

The following systems and components are affected by the proposed changes to TS SR 4.4.5.4.a.7, 4.4.5.4.a.9 and Bases 3/4.4.5: the Reactor Coolant System, Steam Generators, and the Steam Generator tubes inside of the tubesheet.

The following activity is affected: the steam generator tube repair process wherein a new roll expansion joint is created to serve as a pressure boundary when the existing roll expansion joint is determined to be degraded or a defect is determined to exist in the tube within the tube sheet.

FUNCTIONS OF THE AFFECTED SYSTEMS, COMPONENTS, AND ACTIVITIES:

The Reactor Coolant System (RCS) is discussed in the DBNPS Updated Safety Analysis Report (USAR) Section 5.0, "Reactor Coolant System," and USAR Section 6.3, "Emergency Core Cooling System."

The RCS, in general, consists of the reactor vessel, two vertical once-through steam generators, four shaft-sealed reactor coolant pumps, an electrically heated pressurizer, and interconnecting piping. The system, located entirely within the Containment Vessel, is arranged in two heat transport loops, each with two reactor coolant pumps and one steam generator. Reactor coolant is transported through piping connecting the reactor vessel to the steam generators and flows downward through the steam generator tubes, transferring heat to the steam and water on the shell side of the steam generator. In each loop, the reactor coolant is returned to the reactor through two lines, each containing a reactor coolant pump.

The RCS performs the following functions which are important to safe plant operation:

- The RCS transfers heat from the core to the Steam Generators during steady state operation and for any design transient without exceeding core thermal limits.

- The RCS removes decay heat from the core via redundant components and features. The RCS is designed to be capable of natural circulation cooldown from normal operating temperature and pressure to conditions that permit operation of the Decay Heat Removal System.

- The RCS forms a barrier against the release of reactor coolant and radioactive material to the environment.

- The RCS transfers heat from the reactor core to containment during a loss of Steam

Generator cooling with high RCS pressure, utilizing Make-up/High Pressure Injection (MU/HPI) Core Cooling.

The functions of the steam generators are to:

- Provide a pressure boundary between the reactor coolant and the secondary side fluid and to confine fission products and activation products within the reactor coolant system.

- Provide heat transfer capability and a heat sink to remove the reactor coolant heat produced during normal power operations.

- Provide normal and auxiliary feedwater flow paths and heat transfer capability for both normal and emergency cooldown.

- Supply steam for the auxiliary feed pump turbines for emergency cooling.

The repair roll method being modified in this License Amendment Request (LAR) provides a method of repair for steam generator tubes that have sustained degradation of the tube within the steam generator tubesheets. The repair roll is a process whereby a new primary to secondary pressure boundary joint is established by hard rerolling the tube closer to the secondary face of the tubesheet. The new pressure boundary joint is established to remove the area of degradation from pressure boundary service (see attached figure).

EFFECTS ON SAFETY:

By letter dated March 12, 2001, the Babcock and Wilcox Owners' Group (BWOG), of which the DBNPS is a member, submitted to the NRC Topical Report BAW-2374, Revision 1, *Risk-Informed Assessment of Once-Through Steam Generator Tube Thermal Loads Due to Breaks in Reactor Coolant System Upper Hot Leg Large-Bore Piping*. BAW-2374, Revision 1, demonstrates the low risk associated with an upper hot leg large-bore pipe break and provides for the acceptability of basing OTSG thermal loads on the previously analyzed limiting accidents, which are the loss of coolant accident (LOCA) in RCS attached pipes (pressurizer surge line and reactor head continuous vent line) and the main steam line break (MSLB). BAW-2303P, Revision 4, and this LAR utilize the LOCA in RCS attached pipes and the MSLB as the limiting accidents for determining OTSG tube loads.

The DBNPS TS currently permit the use of a single one-inch long tube roll expansion as a repair technique only for tubes with degradation in the upper tubesheet. FTI Topical Report BAW-2303P, Revision 3, "OTSG Repair Roll Qualification Report," provides the current basis for the use of the repair roll process. This LAR requests that the repair requirements of TS 4.4.5.4.a.7 incorporate the repair roll process of Framatome Technologies Incorporated (FTI) Topical Report BAW-2303P, Revision 4. Attached BAW-2303P, Revision 4, includes the following in support of this LAR:

- Repair Roll Description
- Design Requirements

- Transient Analyses (Thermal-Hydraulic and Structural)
- Repair Roll Test Program and Results
- Repair Roll Exclusion Zones
- Application of Leak Rates
- Non-Destructive Examination of Repair Rolls
- Repair Roll Installation Parameters

The DBNPS TS currently limit the repair roll process to the upper tubesheet area only. The proposed changes to TS 4.4.5.4 would define repair rolling as an acceptable tube repair method in both the upper and lower tubesheet areas. BAW-2303P, Revision 4, provides for the qualification of repair rolls in both the upper and lower tubesheet areas. The proposed changes would permit excluding the tube area "outboard " of the new roll area from future periodic inspections because it is no longer part of the pressure boundary once the repair roll is installed. The term "outboard" refers to the area between the new repair roll and the primary face of the tubesheet. Based on the technical justification provided in BAW-2303P, Revision 4, the proposed change to repair roll location requirements will have no adverse effect on nuclear safety.

The DBNPS TS currently limit the installation of repair rolls to only one repair roll per OTSG tube. The proposed changes to TS 4.4.5.4 would eliminate the restriction of only one repair roll per tube. Installation of a repair roll results in a residual compressive load on the OTSG tube. BAW-2303P, Revision 4, provides for multiple repair rolls to be installed in an OTSG tube provided an evaluation of the effect of the resulting compressive tube loads is performed. Based on the technical justification provided in BAW-2303P, Revision 4, the proposed change to repair roll installation requirements will have no adverse effect on nuclear safety.

The DBNPS TS currently limit the repair roll process to a single one-inch long expansion. The proposed changes would allow the use of two overlapping one-inch repair rolls to produce a 1-5/8 inch long double repair roll. The double repair roll process would use the same roll expander used in the single repair roll process. A double repair roll provides greater repair roll joint strength and better limits joint leakage. Double repair roll joints are qualified in FTI Topical Report BAW-2303P, Revision 4. Based on the technical justification provided in BAW-2303P, Revision 4, the proposed use of the double repair roll will have no adverse effect on nuclear safety.

Exclusion zones have been identified within the tubesheets, on a plant-specific basis, where any repair roll is not an acceptable repair process and will not be applied as such. FTI Topical Report BAW-2303P, Revision 3, defined these regions within the upper tubesheet. These exclusion zones were established for the first two inches from the primary and secondary faces and for regions where the tube load exceeded the repair roll strength. Topical Report BAW-2303P, Revision 4, redefines the exclusion zones for the application of single repair rolls based on including the lower tubesheet and based on repair roll slip criteria under faulted conditions, plant-specific tube loads, and tubesheet deflections. Topical Report BAW-2303P, Revision 4, provides the technical justification for the new exclusion zones for the application of repair rolls, and based on this technical justification, the proposed revision to repair roll exclusion zones will have no adverse effect on nuclear safety.

With regards to leakage integrity, the analysis discussed in BAW-2303, Revision 4, assumed worst-case leak rates with a full circumferential 100 percent through-wall flaw at the outboard edge of the reroll, taking no credit for the original roll or tube-to-tubesheet weld. Leakage values were then assigned to tube locations. Topical Report BAW-2303P, Revision 4, (and hence, the proposed TS changes) permit reroll joint slippage confined to the tubesheet under accident conditions for specified repair roll locations, and reroll joint slippage affects the leak rate assigned to a tube location. Leakage past repair rolls will be accounted for to ensure that post-accident OTSG leakage will not exceed that assumed in the accident analyses.

Installation of the repair rolls will be in accordance with Topical Report BAW-2303P, Revision 4. Inspection of the repair roll area prior to installation ensures the new roll area is free of degradation and imperfections. Inspection of the repair roll following installation verifies the repair roll length and ensures the new tube-to-tubesheet joint is free of anomalies.

The OTSG tubes, fabricated from Inconel Alloy 600 material, are known to be susceptible to stress corrosion cracking. Accordingly, a repair roll may eventually exhibit slow growth defects as some of the original roll transitions have experienced. For this reason, the repair roll joint and transitions for all tubes that have been repaired by the repair roll process will be inspected during each steam generator inspection in accordance with SR 4.4.5.9.

The removal of the name "Babcock and Wilcox" is an administrative change to reflect that Framatome ANP has succeeded the Babcock and Wilcox Company. This proposed change will have no adverse effect on nuclear safety.

Based on the analyses performed and discussed above, the proposed Technical Specification revisions will have no adverse effect on nuclear safety.

SIGNIFICANT HAZARDS CONSIDERATION:

The Nuclear Regulatory Commission has provided standards in 10 CFR 50.92(c) for determining whether a significant hazard exists due to a proposed amendment to an Operating License for a facility. A proposed amendment involves no significant hazards consideration if operation of the facility in accordance with the proposed changes would: (1) Not involve a significant increase in the probability or consequences of an accident previously evaluated; (2) Not create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) Not involve a significant reduction in a margin of safety. The Davis-Besse Nuclear Power Station has reviewed the proposed changes and determined that a significant hazards consideration does not exist because operation of the Davis-Besse Nuclear Power Station, (DBNPS) Unit No. 1, in accordance with these changes would:

1a. Not involve a significant increase in the probability of an accident previously evaluated because testing and analysis have shown the once-through steam generator (OTSG) tube repair roll process under the proposed revised Technical Specification (TS) Surveillance Requirement (SR) 4.4.5.4 ensures the new pressure boundary joint created by the repair roll process provides adequate structural and leakage integrity for all normal operating

and accident conditions. In addition, the removal of the name "Babcock and Wilcox" is an administrative change to reflect that Framatome ANP has succeeded the Babcock and Wilcox Company. Therefore, the proposed changes to SR 4.4.5.4 will not increase the probability of a previously evaluated accident.

The proposed change to TS Bases 3/4.4.5 reflects the changes proposed to its associated SR, and does not involve an increase in the probability of an accident previously evaluated.

1b. Not involve a significant increase in the consequences of an accident previously evaluated because the repair roll process under the proposed revised SR 4.4.5.4 ensures the new pressure boundary joint created by the repair roll process provides adequate structural and leakage integrity under all accident conditions. Any leakage resulting from repair roll joint slippage under accident conditions will be accounted for to ensure that post-accident OTSG leakage will not exceed that assumed in the accident analyses. Should a repaired tube fail, the radiological consequences would be bounded by the existing Steam Generator Tube Rupture analysis.

The proposed change to Bases 3/4.4.5 reflects the changes proposed to its associated SR, and does not involve an increase to the consequences of an accident previously evaluated.

2. Not create the possibility of a new or different kind of accident from any accident previously evaluated because there will be no change in the operation of the steam generators or connecting systems as a result of the repair roll process added by the proposed changes to SR 4.4.5.4. The physical changes in the steam generators associated with the repair roll process have been evaluated and do not create the possibility for a new or different kind of accident from any accident previously evaluated, i.e., the physical change in the steam generators is limited to the location and accident slip behavior of the primary to secondary boundary within the tubesheet. Accordingly, these changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

The proposed change to Bases 3/4.4.5 reflects the changes proposed to its associated SR, and does not create the possibility of any new or different kind of accident.

3. Not involve a significant reduction in a margin of safety because tubes with primary system to secondary system boundary joints created by the repair roll have been shown by testing and analysis to satisfy all structural, leakage, and heat transfer requirements. The additional testing of tubes repaired by the repair roll process under existing SR 4.4.5.9 provides continuing inservice monitoring of these tubes such that inservice degradation of tubes repaired by the repair roll process will be detected. Therefore, the changes to SR 4.4.5.4 to modify the repair process do not reduce any margin of safety.

The proposed change to Bases 3/4.4.5 reflects the changes proposed to its associated SR, and does not reduce the margin of safety.

CONCLUSION:

On the basis of the above, the DBNPS has determined that the License Amendment Request does not involve a significant hazards consideration. As this License Amendment Request concerns a proposed change to the Technical Specifications that must be reviewed by the Nuclear Regulatory Commission, this License Amendment Request does not constitute an unreviewed safety question.

ATTACHMENTS:

Attachment 1 contains the proposed marked-up changes for the Operating License.

Attachment 2 is the proprietary Framatome Technologies Incorporated Topical Report BAW-2303P, Revision 4, "OTSG Repair Roll Qualification Report," and supporting proprietary affidavit.

Attachment 3 is the non-proprietary Framatome Technologies Incorporated Topical Report BAW-2303NP, Revision 4, "OTSG Repair Roll Qualification Report."

REFERENCES:

1. USAR Section 5.0, "Reactor Coolant System," through Revision 22.

2. USAR Section 6.3, "Emergency Core Cooling System," through Revision 22.

3. Davis-Besse Nuclear Power Station (DBNPS) Unit No. 1, Operating License NPF-3, Appendix A, Technical Specifications, through Amendment 245.

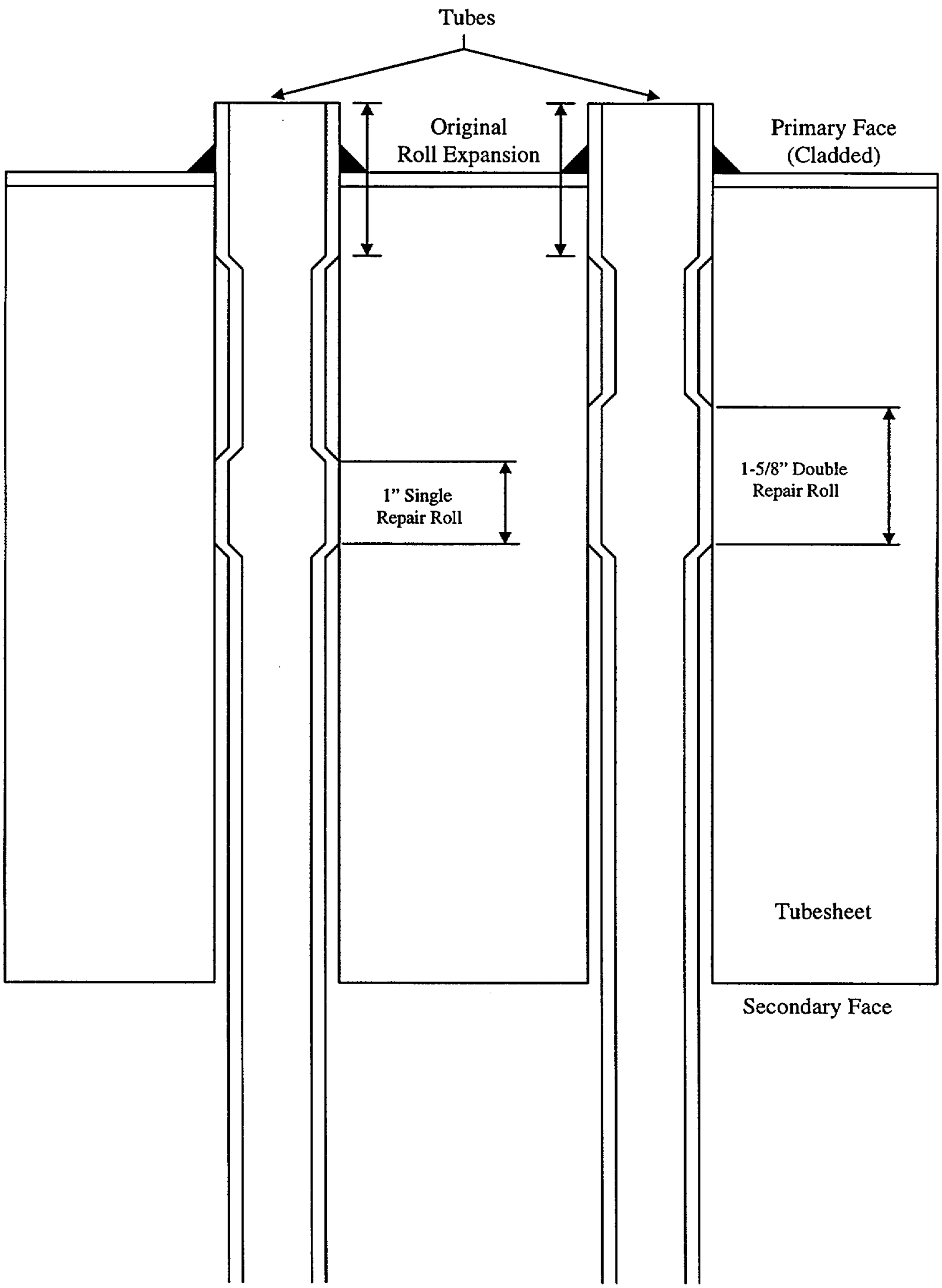
4. DBNPS System Description, SD-041 R1, "Steam Generator."

5. DBNPS System Description, SD-39A, "Reactor Coolant System."

6. Framatome Technologies Incorporated Topical Report BAW-2303P, Revision 3, "OTSG Repair Roll Qualification Report," dated October 1997.

7. Framatome Technologies Incorporated Topical Report BAW-2303P, Revision 4, "OTSG Repair Roll Qualification Report," dated August 2000.

8. Babcock and Wilcox Owners' Group Topical Report BAW-2374, Revision 1, "Risk-Informed Assessment of Once-Through Steam Generator Tube Thermal Loads Due to Breaks in Reactor Coolant System Upper Hot Leg Large-Bore Piping," dated March 2001.



Not to Scale

Figure
Tube Repair Rolls

INFORMATION ONLY

REACTOR COOLANT SYSTEM

STEAM GENERATORS

LIMITING CONDITION FOR OPERATION

3.4.5 Each Steam Generator shall be OPERABLE with a minimum water level of 18 inches and the maximum specified below as applicable:

MODES 1 and 2:

a. The acceptable operating region of Figure 3.4-5.

MODE 3*:

b. 50 inches Startup Range with the SFRCS Low Pressure Trip bypassed and one or both Main Feedwater Pump(s) capable of supplying Feedwater to any Steam Generator.

c. 96 percent Operate Range with:

1. The SFRCS Low Pressure Trip active.

Or

2. The SFRCS Low Pressure Trip bypassed and both Main Feedwater Pumps incapable of supplying Feedwater to the Steam Generators.

MODE 4:

d. 625 inches Full Range Level

APPLICABILITY: MODES 1, 2, 3, and 4, as above.

ACTION:

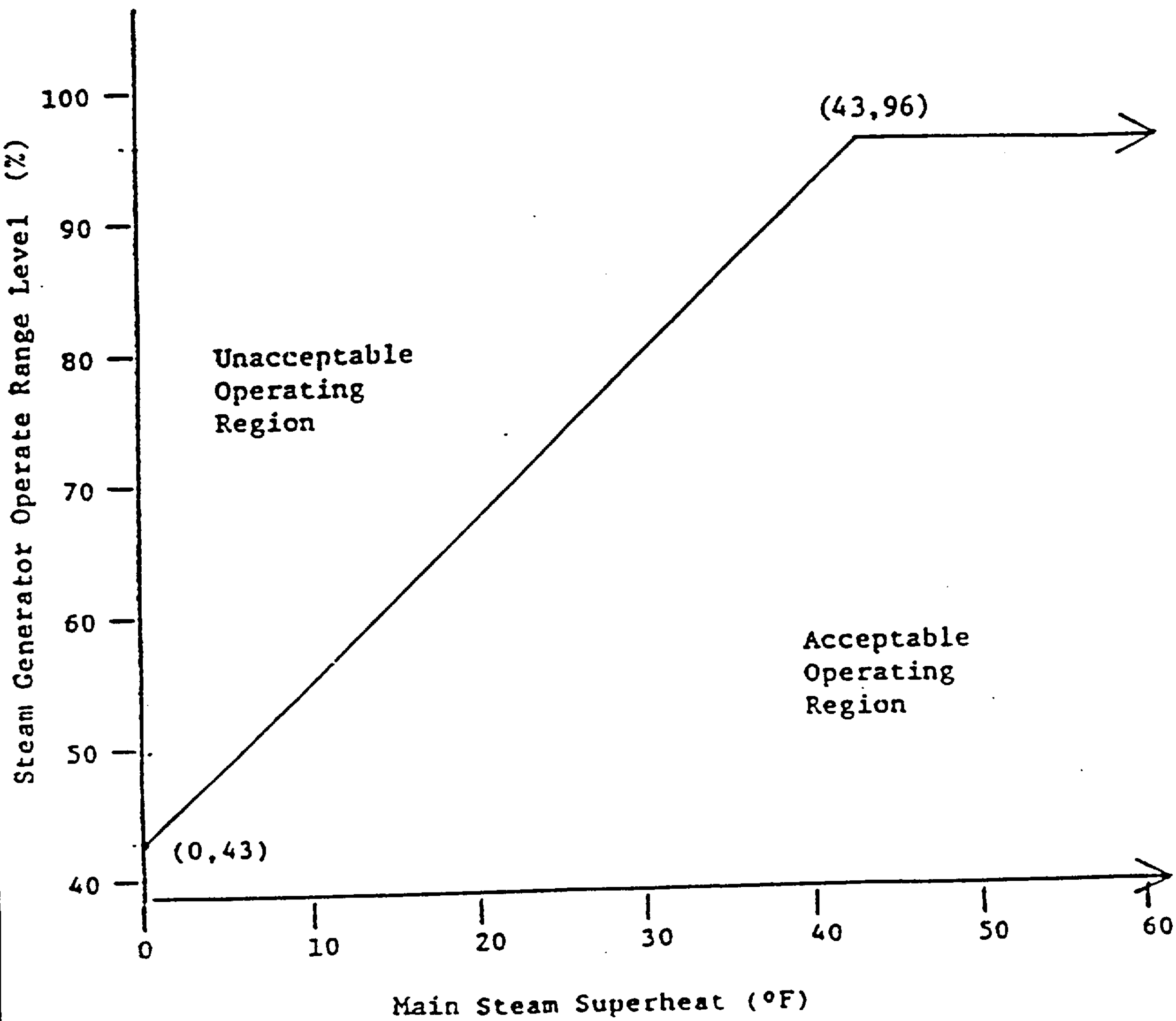
a. With one or more steam generators inoperable due to steam generator tube imperfections, restore the inoperable generator(s) to OPERABLE status prior to increasing T_{avg} above 200°F.

b. With one or more steam generators inoperable due to the water level being outside the limits, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the next 30 hours.

*Establish adequate SHUTDOWN MARGIN to ensure the reactor will stay subcritical during a MODE 3 Main Steam Line Break.

INFORMATION ONLY

Figure 3.4-5
Maximum Allowable Steam Generator Level
in MODES 1 and 2



INFORMATION ONLY

REACTOR COOLANT SYSTEM

STEAM GENERATORS

SURVEILLANCE REQUIREMENTS

4.4.5.0 Each steam generator shall be demonstrated OPERABLE by performance of the following augmented inservice inspection program and the requirements of Specification 4.0.5.

4.4.5.1 Steam Generator Sample Selection and Inspection - Each steam generator shall be determined OPERABLE during shutdown by selecting and inspecting at least the minimum number of steam generators specified in Table 4-4.1.

4.4.5.2 Steam Generator Tube Sample Selection and Inspection - The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.4-2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.4.5.3 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.4.5.4. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in all steam generators; the tubes selected for these inspections shall be selected on a random basis except:

a. The first sample inspection during each inservice inspection of each steam generator shall include:

   1. All tubes or tube sleeves that previously had detectable wall penetrations (> 20%) that have not been plugged or repaired by repair roll or sleeving in the affected area. (Tubes repaired by sleeving or repair roll remain available for random selection).

   2. At least 50% of the tubes inspected shall be in those areas where experience has indicated potential problems.

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SURVEILLANCE REQUIREMENTS (Continued)

3. A tube inspection (pursuant to Specification 4.4.5.4.a.9.) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection.

b. Tubes in the following groups may be excluded from the first random sample if all tubes in a group in both steam generators are inspected. No credit will be taken for these tubes in meeting minimum sample size requirements.

1. Group A-1: Tubes within one, two or three rows of the open inspection lane.

2. Group A-2: Tubes having a drilled opening in the 15th support plate.

3. Group A-3: Tubes included in the rectangle bounded by rows 62 and 90 and by tubes 58 and 76, excluding tubes included in Group A-1.*

c. The tubes selected as the second and third samples (if required by Table 4.4-2) during each inservice inspection may be subjected to less than a full tube inspection provided:

1. The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found.

2. The inspections include those portions of the tubes where imperfections were previously found.

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

* Tubes in Group A-3 shall not be excluded after completion of the fifth refueling outage.

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SURVEILLANCE REQUIREMENTS (Continued)

Notes: (1) In all inspections, previously degraded tubes must exhibit significant (> 10%) further wall penetrations to be included in the above percentage calculations.

(2) Where special inspections are performed pursuant to 4.4.5.2.b, defective or degraded tubes found as a result of the inspection shall be included in determining the Inspection Results Category for that special inspection but need not be included in determining the Inspection Results Category for the general steam generator inspection.

4.4.5.3 Inspection Frequencies - The above required inservice inspections of steam generator tubes shall be performed at the following frequencies:

a. Inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If the results of two consecutive inspections for a given group* of tubes following service under all volatile treatment (AVT) conditions fall into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval for that group may be extended to a maximum of 40 months.

b. If the results of the inservice inspection of a steam generator performed in accordance with Table 4.4-2 at 40 month intervals for a given group* of tubes fall in Category C-3, subsequent inservice inspections shall be performed at intervals of not less than 10 nor more than 20 calendar months after the previous inspection. The increase in inspection frequency shall apply until a subsequent inspection meets the conditions specified in 4.4.5.3a and the interval can be extended to 40 months.

c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.4-2 during the shutdown subsequent to any of the following conditions:

1. Primary-to-secondary tube leaks (not including leaks originating from tube-to tube sheet welds) in excess of the limits of Specification 3.4.6.2.

   If the leak is determined to be from a repair roll joint, rather than selecting a random sample, inspect 100% of the repair roll joints in the affected steam generator. If the results of this inspection fall into the C-3 category, perform additional inspections of the new roll areas in the unaffected steam generator.

*A group of tubes means:
(a) All tubes inspected pursuant to 4.4.5.2.b, or
(b) All tubes in a steam generator less those inspected pursuant to 4.4.5.2.b.

2. A seismic occurrence greater than the Operating Basis Earthquake.

3. A loss-of-coolant accident requiring actuation of the engineered safeguards.

4. A main steam line or feedwater line break.

d. The provisions of Specification 4.0.2 are not applicable.

4.4.5.4 Acceptance Criteria

a. As used in this Specification:

1. Tubing or Tube means that portion of the tube or tube sleeve which forms the primary system to secondary system boundary.

2. Imperfection means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

3. Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.

4. Degraded Tube means a tube containing imperfections ^{3} 20% of the nominal wall thickness caused by degradation that has not been repaired by repair roll or sleeving in the affected area.

5. % Degradation means the percentage of the tube wall thickness affected or removed by degradation.

6. Defect means an imperfection of such severity that it exceeds the repair limit. A defective tube is a tube containing a defect that has not been repaired by repair roll or sleeving in the affected area or a sleeved tube that has a defect in the sleeve.

7. Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or repaired by repair roll or sleeving in the affected area because it may become unserviceable prior to the next inspection and is equal to 40% of the nominal tube wall thickness. The ~~Babcock and Wilcox~~ process described in Topical Report BAW-2120P will be used for sleeving.

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SURVEILLANCE REQUIREMENTS (Continued)

(Continued) 7. ~~The repair roll process will only be used to repair tubes with defects in the upper tubesheet area. The repair roll process will be performed only once per steam generator tube using a 1 inch reroll length. The new roll area must be free of degradation in order for the repair to be considered acceptable.~~ The repair roll process used is described in the Topical Report BAW-2303P, Revision ~~3~~4. The new roll area must be free of degradation in order for the repair to be considered acceptable.

8. Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 4.4.5.3.c, above.

9. Tube Inspection means an inspection of the steam generator tube from the point of entry completely to the point of exit. The previously existing tube and tube roll, ~~above~~ outboard of the new roll area in the ~~upper~~ tube sheet, can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed.

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SURVEILLANCE REQUIREMENTS (Continued)

10. Preservice Inspection means an inspection of the full length of each tube in each steam generator performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial POWER OPERATION using the equipment and techniques expected to be used during subsequent inservice inspections.

b. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug or repair by repair roll or sleeving in the affected areas all tubes exceeding the repair limit and all tubes containing through-wall cracks) required by Table 4.4-2.

4.4.5.5 Reports

a. Following each inservice inspection of steam generator tubes, the number of tubes plugged in each steam generator shall be reported to the Commission within 15 days.

b. The complete results of the steam generator tube inservice inspection shall be submitted on an annual basis in a report for the period in which this inspection was completed. This report shall include:

1. Number and extent of tubes inspected.

2. Location and percent of wall-thickness penetration for each indication of an imperfection.

3. Identification of tubes plugged, sleeved or repair rolled.

c. Results of steam generator tube inspections which fall into Category C-3 and require notification of the Commission shall be reported prior to resumption of plant operation. This report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

4.4.5.6 The steam generator shall be demonstrated OPERABLE by verifying steam generator level to be within limits at least once per 12 hours.

4.4.5.7 When steam generator tube inspection is performed as per Section 4.4.5.2, an additional but totally separate inspection shall be performed on special interest peripheral tubes in the vicinity of the secured internal auxiliary feedwater header. This testing shall only be required on the steam generator selected for inspection, and the test shall require inspection only between

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the upper tube sheet and the 15th tube support plate. The tubes selected for inspection shall represent the entire circumference of the steam generator and shall total at least 150 peripheral tubes.

4.4.5.8 Visual inspections of the secured internal auxiliary feedwater header, header to shroud attachment welds, and the external header thermal sleeves shall be performed on each steam generator through the auxiliary feedwater injection penetrations.

These inspections of the secured internal auxiliary feedwater header, header to shroud attachment welds, and the external header thermal sleeves shall be performed during the third period of each ten-year Inservice Inspection Interval (ISI).

4.4.5.9 When steam generator tube inspection is performed as per Section 4.4.5.2, an additional but totally separate inspection shall be performed on special interest tubes that have been repaired by the repair roll process. This inspection shall be performed on 100% of the tubes that have been repaired by the repair roll process. The inspection shall be limited to the repair roll joint and the roll transitions of the repair roll. Defective or degraded tubes found in the repair roll region as a result of the inspection need not be included in determining the Inspection Results Category for the general steam generator inspection.

TABLE 4.4-1

MINIMUM NUMBER OF STEAM GENERATORS TO BE INSPECTED DURING INSERVICE INSPECTION

Preservice Inspection	No			Yes		
No. of Steam Generators per Unit	Two	Three	Four	Two	Three	Four
First Inservice Inspection	All			One	Two	Two
Second & Subsequent Inservice Inspections	One[1]			One[1]	One[2]	One[3]

Table Notation:

1. The inservice inspection may be limited to one steam generator on a rotating schedule encompassing 3 N % of the tubes (where N is the number of steam generators in the plant) if the results of the first or previous inspections indicate that all steam generators are performing in a like manner. Note that under some circumstances, the operating conditions in one or more steam generators may be found to be more severe than those in other steam generators Under such circum stances the sample sequence shall be modified to inspect the most severe conditions.

2. The other steam generator not inspected during the first inservice inspection shall be inspected. The third and subsequent inspections should follow the instructions described in 1 above.

3. Each of the other two steam generators not inspected during the first inservice inspections shall be inspected during the second and third inspections. The fourth and subsequent inspections shall follow the instructions described in 1 above.

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TABLE 4.4-2
STEAM GENERATOR TUBE INSPECTION

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION		3RD SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required	Result	Action Required
A minimum of S Tubes per S.G. (1)	C-1	None	N/A	N/A	N/A	N/A
	C-2	Plug or repair by repair rolling or sleeving defective tubes and inspect additional 2S tubes in this S.G.	C-1	None	N/A	N/A
			C-2	Plug or repair by repair rolling or sleeving defective tubes and inspect additional 4S tubes in this S.G.	C-1	None
					C-2	Plug or repair by repair rolling or sleeving defective tubes
					C-3	Perform action for C-3 result of first sample
			C-3	Perform action for C-3 result of first sample	N/A	N/A
	C-3	Inspect all tubes in this S.G., plug or repair by repair rolling or sleeving defective tubes and inspect 2S tubes in each other S.G. Report to the NRC prior to resumption of plant operation.	All other S.G.s are C-1	None	N/A	N/A
			Some S.G.s C-2 but no additional S.G. are C-3	Perform action for C-2 result of second sample	N/A	N/A
			Additional S.G. is C-3	Inspect all tubes in each S.G. and plug or repair by repair rolling or sleeving defective tubes. Report to the NRC prior to resumption of plant operation.	N/A	N/A

(1) $S = 3\frac{N}{n}\%$ Where N is the number of steam generators in the unit, and n is the number of steam generators inspected during an inspection.

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3/4.4.4 PRESSURIZER

A steam bubble in the pressurizer ensures that the RCS is not a hydraulically solid system and is capable of accommodating pressure surges during operation. The steam bubble also protects the pressurizer code safety valves and pilot operated relief valve against water relief.

The low level limit is based on providing enough water volume to prevent a reactor coolant system low pressure condition that would actuate the Reactor Protection System or the Safety Feature Actuation System. The high level limit is based on providing enough steam volume to prevent a pressurizer high level as a result of any transient.

The pilot operated relief valve and steam bubble function to relieve RCS pressure during all design transients. Operation of the pilot operated relief valve minimizes the undesirable opening of the spring-loaded pressurizer code safety valves.

3/4.4.5 STEAM GENERATORS

The Surveillance Requirements for inspection of the steam generator tubes ensure that the structural integrity of this portion of the RCS will be maintained. The program for inservice inspection of steam generator tubes is based on a modification of Regulatory Guide 1.83, Revision 1. Inservice inspection of steam generator tubing is essential in order to maintain surveillance of the conditions of the tubes in the event that there is evidence of mechanical damage or progressive degradation due to design, manufacturing errors, or inservice conditions that lead to corrosion. Inservice inspection of steam generator tubing also provides a means of characterizing the nature and cause of any tube degradation so that corrective measures can be taken. A process equivalent to the inspection method described in Topical Report BAW-2120P will be used for inservice inspection of steam generator tube sleeves. This inspection will provide ensurance of RCS integrity.

The plant is expected to be operated in a manner such that the secondary coolant will be maintained within those chemistry limits found to result in negligible corrosion of the steam generator tubes. If the secondary coolant chemistry is not maintained within these chemistry limits, localized corrosion may likely result in stress corrosion cracking. The extent of cracking during plant operation would be limited by the limitation of steam generator tube leakage between the primary coolant system and the secondary coolant system (primary-to-secondary leakage = 150 GPD through any one steam generator). Cracks having a primary-to-secondary leakage less than this limit during operation will have an adequate margin of safety to withstand the loads imposed during normal

REACTOR COOLANT SYSTEM

BASES (Continued)

operation and by postulated accidents. Operating plants have demonstrated that primary-to-secondary leakage of 150 GPD can be detected by monitoring the secondary coolant. Leakage in excess of this limit will require plant shutdown and an unscheduled inspection, during which the leaking tubes will be located and plugged or repaired by repair rolling or sleeving in the affected areas.

Wastage-type defects are unlikely with proper chemistry treatment of the secondary coolant. However, even if a defect should develop in service, it will be found during scheduled inservice steam generator tube examinations. As described in Topical Report BAW-2120P, degradation as small as 20% through wall can be detected in all areas of a tube sleeve except for the roll expanded areas and the sleeve end, where the limit of detectability is 40% through wall. Tubes with imperfections exceeding the repair limit of 40% of the nominal wall thickness will be plugged or repaired by repair rolling or sleeving the affected areas. Davis-Besse will evaluate, and as appropriate implement, better testing methods which are developed and validated for commercial use so as to enable detection of degradation as small as 20% through wall without exception. Until such time as 20% penetration can be detected in the roll expanded areas and the sleeve end, inspection results will be compared to those obtained during the baseline sleeved tube inspection.

An additional repair method for degraded steam generator tubes consists of rerolling the tubes in the ~~upper~~ tubesheet to create a new roll area and pressure boundary for the tube. The repair roll process will ensure that the area of degradation will not serve as a pressure boundary, thus permitting the tube to remain in service. The degraded area of the tube can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed in the ~~upper~~ tubesheet.

All tubes which have been repaired using the repair roll process will have the new roll area inspected during the inservice inspection. Defective or degraded tube indications found in the new roll area as a result of the inspection of the repair roll and any indications found in the originally rolled region of the rerolled tube need not be included in determining the Inspection Results Category for the general steam generator inspection.

The repair roll process will be performed ~~only once per steam generator tube using a 1 inch reroll length~~ as described in the Topical Report BAW-2303P, Revision ~~3~~4. ~~Thus, multiple applications of the rerolling process to any individual tube is not acceptable.~~ The new roll area must be free of degradation in order for the repair to be considered acceptable. After the new roll area is initially deemed acceptable, future degradation in the new roll area will be analyzed to determine if the tube is defective and needs to be removed from service. Leakage from repair rolls will be accounted for to ensure post-accident primary-to-secondary leakage will not exceed that assumed in the safety analyses. ~~The rerolling process is described in the Topical Report BAW-2303P, Revision 3.~~

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Whenever the results of any steam generator tubing inservice inspection fall into Category C-3, these results shall be reported to the Commission prior to resumption of plant operation. Such cases will be considered by the Commission on a case-by-case basis and may result in a requirement for analysis, laboratory examinations, tests, additional eddy-current inspection, and revision of the Technical Specifications, if necessary.

The steam generator water level limits are consistent with the initial assumptions in the USAR. While in MODE 3, examples of Main Feedwater Pumps that are incapable of supplying feedwater to the Steam Generators are tripped pumps or a manual valve closed in the discharge flowpath. The reactivity requirements to ensure adequate SHUTDOWN MARGIN are provided in plant operating procedures.

LAR 01-0004
Attachment 2

PROPRIETARY
FRAMATOME TECHNOLOGIES INCORPORATED
TOPICAL REPORT BAW-2303P, REVISION 4
"OTSG REPAIR ROLL QUALIFICATION REPORT"
AUGUST 2000

AFFIDAVIT OF RAYMOND W. GANTHNER

A. My name is Raymond W. Ganthner. I am Vice-President of Engineering & Licensing for Framatome ANP, Inc. (FRA-ANP), and as such, I am authorized to execute this Affidavit.

B. I am familiar with the criteria applied by FRA-ANP to determine whether certain information of FRA-ANP is proprietary and I am familiar with the procedures established within FRA-ANP to ensure the proper application of these criteria.

C. In determining whether an FRA-ANP document is to be classified as proprietary information, an initial determination is made by the Unit Manager, who is responsible for originating the document, as to whether it falls within the criteria set forth in Paragraph D hereof. If the information falls within any one of these criteria, it is classified as proprietary by the originating Unit Manager. This initial determination is reviewed by the cognizant Section Manager. If the document is designated as proprietary, it is reviewed again by me to assure that the regulatory requirements of 10 CFR Section 2.790 are met.

D. The following information is provided to demonstrate that the provisions of 10 CFR Section 2.790 of the Commission's regulations have been considered:

(i) The information has been held in confidence by FRA-ANP. Copies of the document are clearly identified as proprietary. In addition, whenever FRA-ANP transmits the information to a customer, customer's agent, potential customer or regulatory agency, the transmittal requests the recipient to hold the information as proprietary. Also, in order to strictly limit any potential or actual customer's use of proprietary information, the substance of the following provision is included in all agreements entered into by FRA-ANP, and an equivalent version of the proprietary provision is included in all of FRA-ANP's proposals:

"Any proprietary information concerning Company's or its Supplier's products or manufacturing processes which is so designated by Company or its Suppliers and disclosed to Purchaser incident to the performance of such contract shall remain the property of Company or its Suppliers and is disclosed in confidence, and Purchaser shall not publish or otherwise disclose it to others without the written approval of Company, and no rights, implied or otherwise, are granted to produce or have produced any products or to practice or cause to be practiced any manufacturing processes covered thereby.

Notwithstanding the above, Purchaser may provide the NRC or any other regulatory agency with any such proprietary information as the NRC or such other agency may require; provided, however, that Purchaser shall first give Company written notice of such proposed disclosure and Company shall have the right to amend such proprietary information so as to make it non-proprietary. In the event that Company cannot amend such proprietary information, Purchaser shall prior to disclosing such information, use its best efforts to obtain a commitment from NRC or such other agency to have such information withheld from public inspection.

Company shall be given the right to participate in pursuit of such confidential treatment."

(ii) The following criteria are customarily applied by FRA-ANP in a rational decision process to determine whether the information should be classified as proprietary. Information may be classified as proprietary if one or more of the following criteria are met:

a. Information reveals cost or price information, commercial strategies, production capabilities, or budget levels of FRA-ANP, its customers or suppliers.

b. The information reveals data or material concerning FRA-ANP research or development plans or programs of present or potential competitive advantage to FRA-ANP.

c. The use of the information by a competitor would decrease his expenditures, in time or resources, in designing, producing or marketing a similar product.

d. The information consists of test data or other similar data concerning a process, method or component, the application of which results in a competitive advantage to FRA-ANP.

e. The information reveals special aspects of a process, method, component or the like, the exclusive use of which results in a competitive advantage to FRA-ANP.

f. The information contains ideas for which patent protection may be sought.

The document(s) listed on Exhibit "A", which is attached hereto and made a part hereof, has been evaluated in accordance with normal FRA-ANP procedures with respect to classification and has been found to contain information which falls within one or more of the criteria enumerated above. Exhibit "B", which is attached hereto and made a part hereof, specifically identifies the criteria applicable to the document(s) listed in Exhibit "A".

(iii) The document(s) listed in Exhibit "A", which has been made available to the United States Nuclear Regulatory Commission was made available in confidence with a request that the document(s) and the information contained therein be withheld from public disclosure.

(iv) The information is not available in the open literature and to the best of our knowledge is not known by General Electric, Westinghouse-CE, or other current or potential domestic or foreign competitors of FRA-ANP.

(v) Specific information with regard to whether public disclosure of the information is likely to cause harm to the competitive position of FRA-ANP, taking into account the value of the information to FRA-ANP; the amount of effort or money expended by FRA-ANP developing the information; and the ease or difficulty with which the information could be properly duplicated by others is given in Exhibit "B".

E. I have personally reviewed the document(s) listed on Exhibit "A" and have found that it is considered proprietary by FRA-ANP because it contains information which falls within one or more of the criteria enumerated in Paragraph D, and it is information which is customarily held in confidence and protected as proprietary information by FRA-ANP. This report

comprises information utilized by FRA-ANP in its business which affords FRA-ANP an opportunity to obtain a competitive advantage over those who may wish to know or use the information contained in the document(s).

RW Ganthner

RAYMOND W. GANTHNER

State of Virginia)

) SS. Lynchburg

City of Lynchburg)

Raymond W. Ganthner, being duly sworn, on his oath deposes and says that he is the person who subscribed his name to the foregoing statement, and that the matters and facts set forth in the statement are true.

RW Ganthner

RAYMOND W. GANTHNER

Subscribed and sworn before me
this 15th day of May 2001.

Brenda C. Maddox
Notary Public in and for the City
of Lynchburg, State of Virginia.
I was commissioned a notary public as Brenda C. Cardona.
My Commission Expires July 31, 2003

EXHIBITS A& B

EXHIBIT A

Topical Report BAW-2303, Rev. 4, "OTSG Repair Roll Qualification Report," dated August 2000.

EXHIBIT B

The above listed document contains information which is considered Proprietary in accordance with Criteria b, c, d and e of the attached affidavit.

LAR 01-0004
Attachment 3

NON-PROPRIETARY
FRAMATOME TECHNOLOGIES INCORPORATED
TOPICAL REPORT BAW-2303NP, REVISION 4
"OTSG REPAIR ROLL QUALIFICATION REPORT"
AUGUST 2000

BAW-2303NP
Revision 04
August 2000

OTSG REPAIR ROLL QUALIFICATION REPORT

NON-PROPRIETARY

FRAMATOME TECHNOLOGIES
P.O. BOX 10935
LYNCHBURG, VA 24506-0935

This document is the non-proprietary version of the proprietary document BAW-2303P, Revision 4. In order to qualify as a non-proprietary document, certain blocks of proprietary information have been withheld. The criteria used for withholding information are provided below.

b) The information reveals data or material concerning FTI research or development plans or programs of potential economic advantage to FTI.

c) The use of the information by a competitor would decrease his expenditures, in time or resources, in designing or producing a similar product.

d) The information consists of test data or similar data concerning a process, method, or component, the application of which results in an economic advantage to FTI.

e) The information reveals special aspects of a process, method, component, or the like, the exclusive use of which results in an economic advantage to FTI.

Approvals

Prepared by C. K. Chandler Date: 9/22/00

This report was reviewed and was found to be an accurate description of the work reported.

Reviewed by J. A. Burgess Date: 9/22/00

Verification of Independent Review.

Approved by S. B. Brown
Manager
Steam Generator Engineering
Date: 9/22/00

This report has been approved for release.

Released by D. J. Firth
Program Manager
B&W Owner's Group
Date: 9/26/00

Executive Summary

A repair roll process has been qualified to repair tubes with eddy-current indications within the tubesheet region of the Once-Through Steam Generators (OTSG). The repair roll is a roll expansion installed inboard of the original roll expansion and existing defect indications. The repair roll becomes the new leak-limiting primary-to-secondary pressure boundary for the tube.

A [e] single repair roll, excluding the roll transition closest to the primary side of the tubesheet (heel transition), has been qualified for installation in the OTSGs. [e]

[e]

Repair rolls are qualified in this document for installation in both the upper and lower tubesheets. In addition, multiple repair rolls in a single tube are qualified. A [e] overlapping repair roll, such as those previously installed in some OTSGs under a prior qualification, is bounded by the qualification of the single [e] repair roll.

Plant-specific exclusion zones have been developed for repair roll installation (Appendices A through D). There is a generic exclusion zone that spans the first [e] from the tubesheet faces, primary and secondary. Additional plant-specific exclusion zones are based on plant-specific tube loads and tubesheet deflections.

Initial eddy current (EC) inspection identifies tubes that are candidates for repair roll and locates and characterizes defect indications. Post-repair EC inspection verifies repair roll installation, provides a profile of the inside diameters and verifies that the effective repair roll is free of defects.

All repair rolls installed under previous submittals meet the repair roll qualifications of this topical report.

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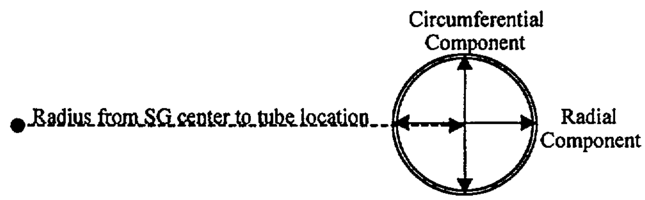
ACRONYMS AND ABBREVIATIONS

ANO-1	Arkansas Nuclear One, Unit 1
AFW	Auxiliary Feedwater
CR-3	Crystal River Unit 3
DB-1	Davis Besse Unit 1
EC	Eddy Current
ECCS	Emergency Core Cooling System
ECT (ET)	Eddy Current Techniques
FE	Finite Element
FTI	Framatome Technologies Inc.
HL	High Load Leak Test
HS	High Load Slip Test
ID	Inner Diameter
IGA	Intergranular Attack
LL	Low Load Leak Test
LS	Low Load Slip Test
LTS	Lower Tubesheet
MSLB	Main Steam Line Break
NOP	Normal Operation
OD	Outer Diameter
ONS	Oconee (Units 1, 2, and 3)
OTSG	Once-Through Steam Generator
PWSCC	Primary Water Stress Corrosion Cracking
RCS	Reactor Coolant System
SBLOCA	Small Break Loss of Coolant Accident
SSE	Safe Shutdown Earthquake
TMI-1	Three Mile Island Unit 1
TSP	Tube Support Plate
UCL	Upper Confidence Limit
UTS	Upper Tubesheet

DEFINITIONS

Differential dilation

The calculated difference between the transient-induced change in the tubesheet bore ID and the tube OD. Equal to the tubesheet bore dilation (due to tubesheet bowing and free thermal growth) minus the tube dilation (due to internal pressure and free thermal growth). Based on diametrical changes along two perpendicular axes (See Figure below). A positive differential dilation represents a decrease in the interference between the tube repair roll joint and the tubesheet bore. A negative differential dilation represents an increase in the interference between the tube repair roll and the tubesheet bore.



Bore dilation

The change in the diameter of the tubesheet bore ID relative to the "as manufactured" condition. Normalized transient bore dilations refer to the predicted transient conditions, corrected for test temperature and pressure conditions. Test bore dilations refer to the bore dilations applied to the test mock-ups during room temperature testing.

Heel transition

The roller on the roll expander has tapered ends that produce a transition between the expanded tube region and the non-expanded tube region. The heel transition is the transition closest to the primary face of the tubesheet (the upper roll transition for a repair roll installed in the upper tubesheet). The heel transition is not considered part of the new pressure boundary.

Toe transition

The roller on the roll expander has tapered ends that produce a transition between the expanded tube region and the non-expanded tube region. The toe transition is the transition closest to the secondary face of the tubesheet (the lower roll transition for a repair roll installed in the upper tubesheet). The toe transition is part of the new leak-limiting pressure boundary, but it is not

	included as part of the effective length of the repair roll.
Exclusion Zone	A tubesheet depth and radial location that has not been qualified for installation of a repair roll. An exclusion zone of [e] from the secondary tubesheet face prevents the tube from slipping out of the tubesheet. An exclusion zone of [e] from the primary tubesheet face prevents overlap of the original tube-to-tubesheet expansion roll. Additional exclusion zones are identified based on the limits defined by the qualifying repair roll tests.

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to provide a technical justification to implement a tubesheet region repair roll in degraded tubes in Once-Through Steam Generators (OTSGs). A repair roll installed inboard of the degraded region of tubing provides a frictional joint of undegraded tubing within the tubesheet bore, which creates a new leak-limiting primary-to-secondary pressure boundary within the tubesheet.

A repair roll in the upper tubesheet has been qualified under previous submittals; however, requalification is necessary due to identification of a more limiting Small Break Loss of Coolant Accident (SBLOCA) that was not included in the previous evaluation. In addition, the Main Steam Line Break (MSLB) transient has been re-analyzed, resulting in a new set of design loads for each plant. Also, repair rolls are qualified in this document for installation in both the upper and lower tubesheets and multiple repair rolls in a single tube are qualified. [c]

Repair rolls that have been installed under previous submittals remain qualified based on the requirements of this topical report.

The qualification of the OTSG repair roll presented in this report applies to the following OTSG plants:

Arkansas Nuclear One, Unit 1 (ANO-1)

Crystal River Unit 3 (CR-3)

Davis Besse Unit 1 (DB-1

Oconee Units 1, 2, and 3 (ONS-1, ONS-2, and ONS-3)

Three Mile Island Unit 1 (TMI-1) in-service steam generator tubes were kinetically expanded in the early 1980's after a cold shutdown. The kinetic expansion serves as the primary-to-secondary pressure boundary. Therefore, TMI-1 does not anticipate the need for repair rolls in the upper tubesheet. An addendum may be added to this report in the future if the need arises for repair rolls at TMI-1.

1.2 Background

Eddy Current (EC) inspections of OTSG tubes have resulted in the detection of indications within the upper and lower tubesheet region. These indications are typically axial crack-like indications located within the existing upper tubesheet. A much smaller number of circumferential crack-like indications have been identified in this region. Tube pull examinations have shown that

2.0 REPAIR ROLL DESCRIPTION

2.1 Repair Roll Design

Two types of repair rolls have been developed for installation in the OTSGs, a single [e] roll expansion and an overlapping roll that consists of two [e] roll expansions. The single roll expansion provides a [e] effective roll. For the overlapping roll, a second repair roll is installed that overlaps a single repair roll. Figure 2.1 provides an illustration of the repair rolls. The overlapping roll provides a minimum [e] effective roll expansion.

There is an additional [e] roll transition region on each end of the roll expansion. The new leak-limiting pressure boundary created by the repair roll does not include the heel transition, which is the transition closest to the tube end (primary side).

Both the single repair roll and the overlapping repair roll may be installed in the upper tubesheet or the lower tubesheet. Multiple repair rolls may be installed in a single tube. [e]

During installation of repair rolls, a [b] load is imparted to the tube. Testing was conducted by measuring the amount of tube protrusion past the [b] face of a mock-up block (at four positions around the tube), both before and after each rolling process. The average change in protrusion was considered tube elongation induced by each rolling process. [b] loads were calculated based on the stress-strain relationship. The 95/95 upper tolerance limits for the [b] loads are [b] for a single [e] repair roll and varies from [b] to [b] for an overlapping repair load depending on the method of installation.

There are three overlapping roll configurations that may be installed. [e & b]

The preferred configuration is dependent on the [b] load limits and the characterization of the degradation requiring a repair roll.

The [b] load due to installation of a repair roll is added to the predicted [b] load due to operating transients. The additional [b] load due to [b] single [e] repair rolls, [b], or the maximum additional [b] load due to [e] overlapping repair roll, [b], is negligible compared to the worst-case [c] loads due to [c]

presented in Table 4-1. Additional repair rolls may be installed on a case-by-case basis by evaluating for acceptable [b] tube loads.

2.2 Repair Roll Installation

The repair roll is typically installed remotely using a manipulator and a DELTA plugging type tool head. A control system is used to position and install the new roll expansion. The required roll torque is [e] using the standard qualified tooling. Spacers between the tool and tubesheet or tube end are used to establish the amount of overlap, if any, and the proper roll depth within the candidate tube. [e] is used to lubricate the expander rollers to enhance the quality of the roll expansion by reducing energy loss.

The qualified repair roll process tool assembly (e.g. DELTA tool) is calibrated to deliver the specified roll torque of [e] within a measured tube inner diameter. A test roll is performed prior to roll expansion of the target tubes. A time history of the torque and diametrical expansion is recorded for reference for each candidate location. At the completion of a specified number of repair rolls (or batch), a post-calibration check is conducted to verify that the tool was calibrated during the installation of the repair rolls.

2.3 Process Verification

Qualified Eddy Current Techniques (ECT) are used to identify candidate tube locations for repair and to determine the defect locations. After repair roll installation, bobbin profilometry is used to confirm diametrical expansion. Inspection with a rotating coil is used to verify that the new effective roll expansion is free of degradation. (See Section 8.0.)

Figure 2-1 Tube Repair Roll Configuration

[e]

3.0 DESIGN REQUIREMENTS

3.1 General Design Requirements

The OTSG tubes are constrained at the upper and lower tubesheet; therefore, tube burst within the new roll expansion is precluded by the presence of the tubesheet. The new roll expansion will be subjected to axial tube loads that must be considered when evaluating the structural integrity of the joint. The source of the axial tube loads is the differential pressures across the tubesheets and the differential thermal growth of the tubes and tubesheet relative to the OTSG shell. [e]

[e]

In addition, the repair roll shall provide a mechanical pressure boundary seal between the existing tube and tubesheet. The new joint shall provide leak-limiting capability, assuming a full sever between the repair roll and the tube end. Total leakage must be maintained below the technical specification limits for normal operation and plant-specific limits for faulted conditions.

The repair roll must be installed remote from the original roll expansion and all EC indications of degradation.

3.2 OTSG Performance Characteristics and Design Transients

The applicable design, operational, and accident performance characteristics, including pressures and temperatures for the Babcock and Wilcox 177 FA OTSGs are provided in Table 3-1. Figure 3-1 is an illustration of the OTSG general assembly. The transients listed in Table 3-2 represent the range of limiting conditions that could challenge the structural and leakage integrity of the repair rolls. The Functional Specification transients for the OTSGs are either applied or are considered bounded by the transients listed in Table 3-2.

Table 3-1 B&W OTSG (177FA) PERFORMANCE CHARACTERISTICS

	PRIMARY SIDE	SECONDARY SIDE
DESIGN CONDITIONS		
Design Pressure, psig	2500	1050
Design Temperature, °F	650	600
LEVEL A (NORMAL OPERATIONS) CONDITIONS (100% FULL POWER)		
Pressure, psia	2200	925
Temperature, Inlet, °F (DB-1)	604 (608)	459 (470)
Temperature, Outlet, °F (DB-1)	554 (556)	570 (570)
LEVEL D (FAULTED) CONDITIONS		
(Additional information and loads provided in Section 4.0)		
Main Steam Line Break		
Maximum Primary-to-Secondary Pressure Differential, psig	2575	
Small Break Loss of Coolant Accident*		
Maximum Secondary-to-Primary Pressure Differential, psig	1050	

*[c]

Figure 3-1 OTSG General Assembly

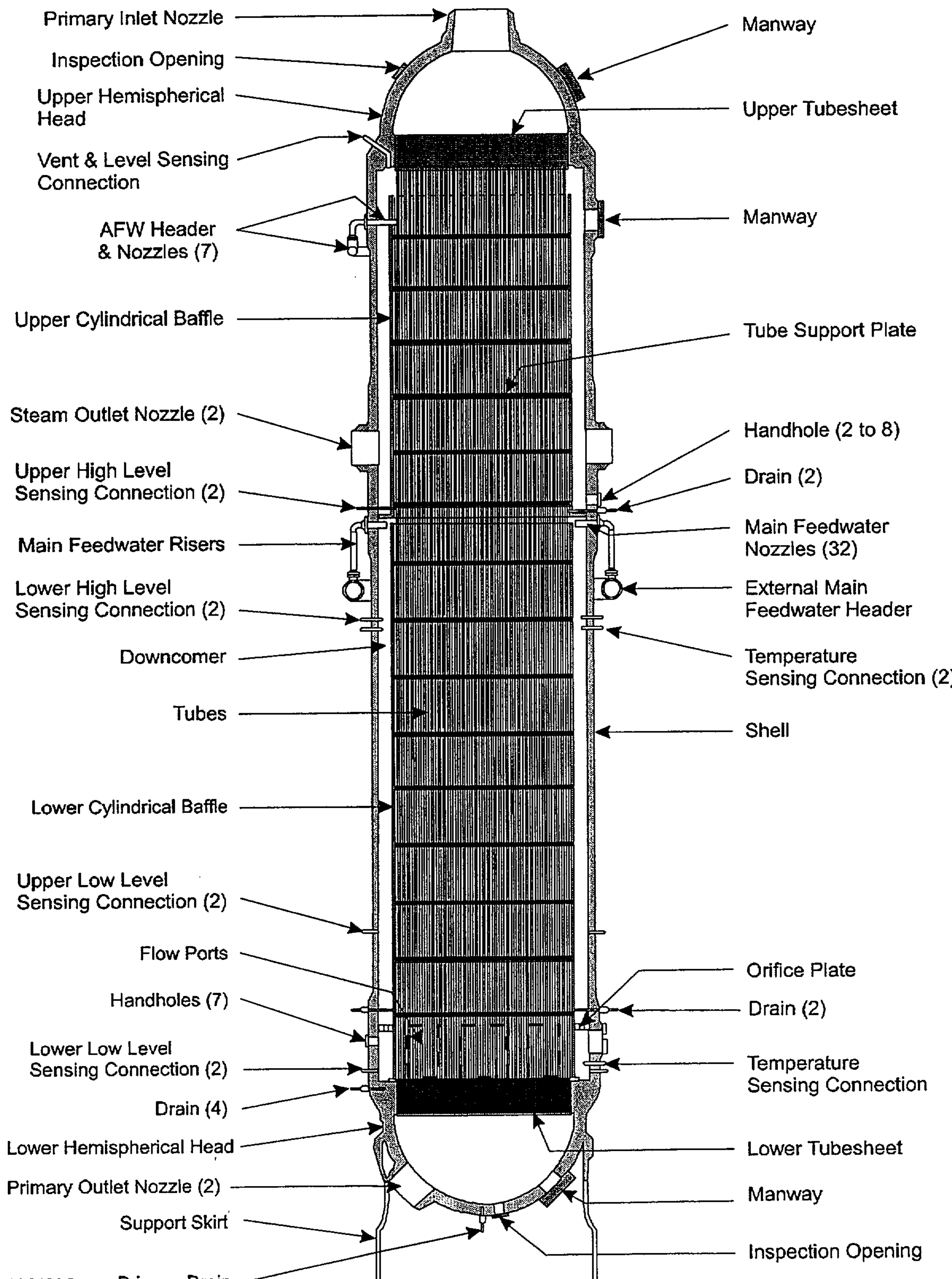


Table 3-2 Bounding Repair Roll Design Transients

[c]

*Refer to Section 4.8 for further discussion on bounding transients.

4.0 TRANSIENT ANALYSES

The general structural behavior of the OTSG during the various operating and accident transients was quantified by the development of a finite element (FE) model of the overall OTSG, including the tube bundle, the tubesheets, shell, heads, and support skirt.

Due to the straight tube design of the OTSG, the axial stiffness of the tubes interacts with the axial stiffness of the adjacent secondary shell. The interaction of the tubes and shell results in axial tube loads, which are dependent on the combinations of temperatures and pressures. Transients that result in a temperature differential between tubes and the shell cause a bowing of the tubesheets, which results in higher tube loads in the periphery, where the tubesheet is fixed. The pressure differential across the circular (flat plate) tubesheets causes a "diaphragm effect" that also results in tubesheet bowing. The pressure differential may augment or resist the thermal bowing effects. The resulting bowing effect can produce a dilation of the tubesheet bore in the region of the tube-to-tubesheet joint, which may reduce the load carrying capability of the rolled joint. Therefore, the FE analysis was developed to model the general structural behavior of the OTSG, including deflections and axial tube loads, and the local structural behavior (hole dilations).

The FE analyses provided axial tube loads and the data required to calculate tube and tubesheet bore dilations. The tube dilations were calculated based on the applicable tube temperature and pressure values. The tubesheet bore dilations, when coupled with the tube dilations, provide a representation of the joint interface, which is referred to as differential dilations (See Section 4.8).

The axial tube loads calculated by these analyses supersede all previously calculated axial tube loads.

4.1 Development of the Finite Element (FE) Model

The general structural behavior of the OTSG is governed by the response of the OTSG to applied thermal loads such as temperature transients as well as mechanical loads such as preload, primary pressure, and secondary pressure. The development and execution of a FE model of the overall OTSG quantified the general structural behavior. Figure 4.1 depicts the lower portion of the OTSG model and provides an example of the model grid.

To represent the structural behavior affecting the axial tube loads and associated tube hole dilations, the OTSG FE model included the tubes, tubesheets, secondary shell, the upper and lower heads, and the support skirt. The tubesheet components have been subdivided into two regions – 1) the region perforated with tube holes (over 15,000 tube holes per tubesheet), including the [b] solid center and 2) the solid region (outside of the perforated region). This division facilitated the application of the "equivalent plate" material properties to the perforated region.

Because the key results are a function of the overall OTSG stiffness, as reflected by the shell and tubes, it was important to represent the [b] stiffness of these sub-components. Therefore, the model used the [b] thickness for the shell and tubes.

The original manufacturer's tube-to-tubesheet joint includes both a rolled joint, typically [e] long at the primary face of the tubesheet, and a fillet weld. The rolled expansion produced an interface pressure between the tube OD and the tubesheet bore ID. The residual pressure generated a localized residual stress in the tubesheet around each tube hole. The collective effect of these residual stress fields, acting in the [c] layer at the primary tubesheet faces, on the effective stiffness of the [b] thick tubesheet was [c] in the transient analyses. The effect of this local residual stress field is an [c] influence on the general response of the OTSG.

The OTSG internal structures were [c] in the model. An evaluation determined that the lateral support/restraint provided by the tube support plates (TSPs) has a [c] impact on the general structural behavior of the OTSG. The evaluation [c] the lateral restraint of the tubes at the TSPs, the restraint of the tubes at the [c] face of the tubesheets due to [c] prior to impacting the tubesheet bore, and stress stiffening of the tube under displacement. The collective bending resistance of the tubes [c] that [c] reaction moment resulted at their connections to the tubesheets. Thus, [c] due to this reaction moment [c] for tubesheet motions or the associated tubesheet hole dilations.

The vertical support provided to the TSPs by the tie-rods and spacers was [c] in the model. These components generally produced a [c] to the lower tubesheet, which would be applied as a [c] to the tubesheet at [b] support spacer locations. For the case of a secondary side blowdown, such as during the initial phase of a Main Steam Line Break (MSLB) transient, the collective differential pressure across the support plates may potentially result in a [c] reacting on the [b] tie-rod locations of the lower tubesheet. This [c] load would occur only during the blowdown phase, which lasts a short time, and is dissipated before the more dominant loads caused by maximum tube-to-shell temperature differential and primary-to-secondary pressure differential are developed.

The mounting plate of the lower shroud, which mounts directly on top of the recessed area of the lower tubesheet, was [c] in the FE model. The mounting plate [b] heat flow from the [b] water into the interfacing tubesheet rim (or out of the tubesheet rim into the [b] water). Effective heat transfer coefficients that accounted for the [b] heat flow [c] to the interfacing tubesheet area. Therefore, [c] the mounting plate was [c], its effect on the thermal distributions of the lower tubesheet [c].

The upper shroud shelf plate [c] in the model as an [c] of the steam and feedwater downcomer regions of the model. The shelf plate had [c] relating to the structural behavior of the overall model.

Based on the nature and the magnitude of the loads, a linear-elastic, axisymmetric model was selected as the appropriate model type. The constructed FE model is representative of all B&W 177FA OTSGs. The major sub-components for the various plants have essentially the same dimensions and material designations. However, there are some minor differences that required assessment and disposition.

Figure 4-1 Lower Portion of OTSG Finite Element Model

[c]

4.2 Model Parameter Assessment

As noted above, there are some minor differences among the OTSGs. Parameter assessments were performed to assure that the analytical model conservatively includes any significant effects of these features. Each parameter assessment consisted of comparing the results from representative test loading on the model with the feature included to the results for the same test loading without the feature (base case). The key results used in the comparison were the axial tube loads and the associated maximum tubesheet bore dilations. The conclusions from the assessments resulted in the incorporation of model features based on conservative effects or as a more realistic representation of the physical OTSG.

The parameter assessments included, but were not limited to the following:

[b & c]

[b & c]

[b & c]

[b & c]

[b & c]

[b & c]

[b & c]

4.3 Analyzed Transients

The OTSG structural model described above was used to analyze transient conditions for assessment of the tube-to-tubesheet joints.

The design transients listed in Table 3-2 were analyzed. The Functional Specification transients for the OTSGs are either applied or are considered bounded by the transients listed in Table 3-2. The normal operating and upset transients were evaluated as transients that result in cyclic loadings and the bounding transients were selected for analyses. The emergency and faulted transients were evaluated as transients that are postulated to occur

only once or a minimum number of times in the life of the OTSGs, but generally result in more severe loading conditions than those of the normal operating and upset transients. The bounding transients for emergency and faulted conditions were selected for analyses. [c], an evaluation was performed to verify that the bounding transient for normal operating and upset conditions also bounds the emergency transients for load and differential dilations as discussed further in Section 4.8.

[c]

4.4 Thermal-Hydraulic Results

The transient time points that represent the most severe temperature distribution for each accident transient were determined from the results of the FE model thermal analyses. The thermal analyses were performed by FTI, except for the [c], which was provided by Duke Power Company. The FTI thermal-hydraulic analyses were performed using RELAP5/MOD2. The two prime contributions to tube loads and accompanying tube hole dilations are the primary-to-secondary pressure differential and the tube-to-shell temperature differential, with the dominant contribution from the [b]. [c]. The thermal analyses provided primary and secondary fluid temperatures, primary flow, average shell temperature, heat transfer coefficients, and film coefficients and bulk fluid temperatures for the downcomer region.

Figure 4-2 provides a time-history of the tube-to-shell temperature difference and primary-to-secondary pressure differential for the [c] Note that the maximum MSLB primary-to-secondary pressure differential, based on the maximum possible pressure differential of 2575 psig (derived from the safety relief valve setpoint with a 3% allowance for the setpoint tolerance) occurs [c] the maximum tube-to-shell temperature differential that occurs at approximately [b] into the transient. All of the plant-specific [c] analyses were based on a maximum possible pressure differential of 2575 psig. (The [b] transient analyses ended just prior to reaching a pressure differential of 2575 psig.)

Figure 4-3 provides the time-history of the tube-to-shell temperature difference and primary-to-secondary pressure differential for the [c]. Note that the primary-to-secondary pressure differential is [c] than the primary-to-secondary pressure differential for the [c] and is nearly [c] at the time of maximum tube-to-shell temperature difference.

Figure 4-4 provides the time-history of the tube-to-shell temperature difference and primary-to-secondary pressure differential for the [c]. Note that the primary-to-secondary pressure differential is [c] than the primary-to-secondary pressure differential for the [c].

Therefore, the [c] is the limiting accident for [c], based on [c].

The transient time point of maximum [c] was analyzed with the time of initial conditions, time points before and after the maximum [c], and near the end of the transient. The nodal temperatures throughout the FE model for each time point were used as input to the static structural analyses.

Figure 4-2 [c] Thermal-Hydraulic Results

[c]

Figure 4-3 [c] Thermal-Hydraulic Results

[c]

Figure 4-4 [c] Thermal-Hydraulic Results

[c]

4.5 Thermal Boundary Conditions

For the analyzed transients, the [b] load relative to axial tube loads and dilations is the [b]. The thermal loads were applied to the FE model by specifying a bulk fluid temperature at a surface and a corresponding heat transfer film coefficient or by specifying an assigned temperature. For example, the appropriate bulk fluid temperature and heat transfer coefficient were applied versus time for surfaces such as the upper and lower head inside surfaces, solid tubesheet rim surfaces, shell steam annulus, and shell feedwater downcomer above and below the water level. On the other hand, temperatures versus time were assigned based on the parameters of the specific transient to the perforated portion of the upper and lower tubesheets and the free length of the tubes.

The heat transfer film coefficients were calculated for the normal operating transients based on standard correlations using the transient specific parameters, including temperature ramps and flow rates. However, the heat transfer coefficients for the accident transients were taken from the thermal-hydraulic transient analyses to assure a continuity and consistency with the structural analysis for the rapidly varying and change-of-phase heat transfer regimes.

The outside surface of the OTSG was assumed to be perfectly insulated. This assumption has no significant effect on the range of loads/dilations for normal operating transients and yielded [c] for the accident transients. Thus, the assumption tended to maintain the shell temperature at a higher temperature, maximizing the tube-to-shell temperature difference.

The lower portion of the support skirt was assigned a constant temperature of 120°F to approximate ambient conditions. This has no significant effect on the loads or dilations since this region is well removed from the tube-tubesheet-shell interaction.

The thermal boundary conditions described above were applied to the FE model and the temperature distribution was calculated versus transient time as nodal temperatures.

4.6 Structural Boundary Conditions

As described above, a static structural analysis was performed for critical transient time points determined in the thermal analyses. The applied thermal boundary conditions for each time point or the nodal temperatures from the thermal analyses and the mechanical loads that occur simultaneously with the nodal temperatures were applied to the structural model. The mechanical loads included primary pressure, secondary pressure, and installed tube preload (OTSG tubes were preloaded during fabrication). The dynamic loads were added to the results of the FE analyses and assessed during the qualification testing (Section 5.1.5).

Consistent with the actual OTSG geometry, the pressure loads on the faces of the upper and lower tubesheets were adjusted to account for the tube holes. Plugged tubes were modeled with pressure acting on the plug ends. Poisson's effect in the tube axial direction caused by the pressure differential across the tube wall was applied to the model by imposing an equivalent axial strain on the tube elements.

Similar to the axial tube load due to internal pressure, the tube preload was applied to the model as an axial strain equivalent to the force associated with the tube elongation applied at the time of OTSG fabrication.

4.7 Plugged Tubes

Tube loads and dilations were generated for the case of a steam generator with no plugged tubes (0%) and for the case of a steam generator with [c] plugged tubes. Two configurations were evaluated for plugged tubes. One configuration incorporated the [c] plugged tubes uniformly distributed over the tube bundle. The other configuration used [c] of the plugged tubes concentrated at the periphery of the tube bundle and [c] of the plugged tubes distributed over the remainder of the tube bundle. These distributions are representative of the existing plugging patterns of the OTSGs. The [c] and [c] plugged tube cases were [c] for the OTSGs. Note that no OTSG is approaching [c] plugging.

The difference in the analyses of the plugged and non-plugged tube cases was the temperature imposed on plugged tubes and the absence of primary pressure in the plugged tubes. The plugged tubes were assigned the secondary side temperature and pressure.

4.8 Structural Analyses Results

The FE model was analyzed for each critical time point identified in the thermal analyses. The key results include:

a) Axial tube loads as a function of tubesheet radial position,

b) Tube-to-tubesheet hole differential dilations as a function of tubesheet radial position, and

c) Tube-to-tubesheet hole differential dilations as a function of depth into the tubesheet.

Differential dilation is a term that is used to refer to the interface between the tube OD and the tubesheet bore diameter, which allows a comparison of the relative interface of the joint for any transient condition. The differential dilation is equal to the tubesheet bore dilation (due to tubesheet bowing and free thermal growth) minus the tube dilation (due to internal pressure and free thermal growth). A positive value indicates that the increase in bore diameter is greater than the increase in the tube OD with a reduced interference within the rolled joint. A negative value indicates that the tube free expansion would be greater than the bore expansion resulting in an increase in the interference

pressure of the rolled joint. The differential dilations are expressed as diametrical changes along two perpendicular axes. “Radial” refers to the dilation along the radius from OTSG center to the tube centerline and “circumferential” refers to the dilation perpendicular to the radial dilation.

The finite element transient analyses results were summarized for both the upper and lower tubesheets.

Tables 4-1 and 4-2 provide the key analysis results at the time of maximum load. A positive tube load indicates a tensile load and a negative tube load indicates a compressive load.

Table 4-1 provides the key analysis results for the normal operating and upset transients. The results are provided at the time of maximum tube load. For information and to compare the transient conditions, the differential dilations at the [c] are provided. The differential dilations vary through the thickness of the tubesheet and are typically [c]. The development of the exclusion zones for the repair rolls are based on the calculated differential dilations at a specific tubesheet depth and radial position. As stated previously there is an exclusion zone that spans the first [e] from each tubesheet face.

Table 4-2 provides the analyses results for the bounding [c]. Results are provided at the time of maximum tube load. Figures 4-5 and 4-6 show example plots of differential dilations versus tubesheet radius and depth for the [c] transient. As noted previously, the average differential dilations are [c]. The exclusion zones are based on axial tube loads and differential dilations at a specific tubesheet depth and radial position. Figure 4-7 provides an example plot of the [c] loads as a function of tubesheet radial location.

Based on the results of the transient analyses shown in Table 4-1, the bounding normal operating transient for [c]. The [c] transient represents the [c] differential dilations for normal operation. The [c] transients that were analyzed bound the [c] transients for all OTSGs. The emergency transient, a Stuck-Open Turbine Bypass Valve, was not analyzed and was considered bounded by the [c] transients. However, the emergency transient was evaluated for axial loads, differential dilations, and primary-to-secondary pressure differential and compared to the [c] transient. The maximum tube load is approximately [b], which is bounded by the [c] as shown in Table 4-1. The differential dilations are also bounded by the [c] because the tube loads are [b] and the tubesheet metal remains above [b]; therefore [b] radial strains are generated which causes tubesheet bore dilations. Therefore, the [c] bounds all [c] transients for slippage. The maximum pressure differential for the

emergency transient is approximately [b], which is limited by the [c]transient for leakage.

The bounding transient for [c] loads, normal operating and accident, is the [c] transient. Additional repair rolls installed on a case-by-case basis must be evaluated for acceptable [c] tube loads by adding the additional [c] load from the repair roll to the [c] tube load from the [c] transient for the tube radial position.

Based on the results of the thermal-hydraulic analyses shown in Figures 4-5, Figure 4-6 and Figure 4-7, the [c] is the limiting accident transient for [c], based on the [c]. [c] [c].

The limiting accident transient for load-carrying capability of the repair roll is a function of [c]. For [c], the [d] is the limiting accident transient since both the maximum [c] are much greater than for the [c]. For [c], the limiting transient varies depending on the combination of [c] as a function of tubesheet depth and radial position. Based on [c] alone, the [c] is the limiting transient for [c] and the [c] is the limiting transient for [c].

In summary, the [c] is the limiting transient for normal operating transients, upset transients, and emergency transients in regards to [c] The [c] is the limiting transient for [c]. Overall, the [c] is the limiting transient for faulted transients in regards to [c]

Table 4-1 Normal Operating Transient Analyses Results

Transient	Maximum Tube Load (lbs)	Radial Differential Dilation* (mils)	Circum. Differential Dilation* (mils)	Primary Pressure (psia)	Secondary Pressure (psia)
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]

*[c & e]

Table 4-2 Faulted Accident Transient Analyses Results

Transient	Maximum Tube Load (lbs)	Radial Differential Dilation* (mils)	Circum. Differential Dilation* (mils)	Primary Pressure (psia)	Secondary Pressure (psia)
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]
[c]	[c]	[c]	[c]	[c]	[c]

*[c & e]

Figure 4-5 Differential Dilations versus Tubesheet Radial Location

[c]

Figure 4-6 Differential Dilations versus Tubesheet Depth

[c]

5.0 REPAIR ROLL TEST PROGRAM

5.1 Test Requirements and Conditions

The OTSG transient conditions specified in Section 4.8 were evaluated to develop a set of bounding test conditions for application to single repair rolls and over-lapping repair rolls. Determination of repair roll joint integrity required both slip and leak tests. Slip tests include an applied axial tube load and tubesheet bore dilations with no internal pressure. Tube movement was monitored to detect slippage. Leak tests included internal pressure and applied axial tube load and tubesheet bore dilations. The test pressure was held for 20 minutes while leakage and tube movement were recorded.

5.1.1 Effects of Crevice Deposits

Examination of tube sections removed from the upper tubesheet crevice has shown this region to be free of solid particles. However, the lower tubesheet crevice is known to contain solid particles in the sludge that collects in this region. Previous testing had demonstrated that leak rates are [b] for repair rolls [b] crevice deposits. Therefore, leak tests performed [b] crevice deposits provided conservative leak rates for upper tubesheet and lower tubesheet repair rolls. In addition, previous testing has shown that the joint strength is [b] for rolled joints [b] deposits. Therefore, testing [b] crevice deposits is conservative for both leakage and structural integrity.

5.1.2 Effects of Cyclic Loading

During the design life of the repair roll, the rolled joint is subjected to compressive and tensile tube loads associated with normal operating and steam generator transient conditions. Previous testing has shown that the cyclic loading associated with normal operating and steam generator transient conditions [b] the integrity of the repair roll. Cyclic loading has been shown to result in [b] joint strength for both high yield and low yield tubing. Previous repair roll leak test resulted in [b] leakage for test samples [b] deposits that were [b] to cyclic loading prior to testing than for sample [b] deposits that [b] to cyclic loading prior to testing. Therefore, all leak and load testing to support this qualification of the repair roll was conservatively performed on samples that were [b].

5.1.3 Tube Yield Strength

Recent tests have indicated that the yield strength of the tubing affects the load capacity of the rolled joint, with a [b] yield tubing resulting in a [b] roll joint strength. Application of the axial load on the tube results in [b] the contact pressure over some extent of the rolled joint. As the yield strength of the tubing is [b], a larger extent of the roll joint is

Equation 1 Free Tube Dilation Due to Pressure

$$\Delta d_P = 4 \times \frac{P \times R_{tube}^2 \times R_{TS}}{E_{tube} \times (R_{TS}^2 - R_{tube}^2)}$$

where:

Δd_P	Diametrical dilation of tube OD due to primary pressure (inches)
P	Primary pressure (2575 psig)
R_{tube}	Expanded inner radius of tube ([b] inches)
R_{TS}	Tubesheet bore radius ([b] inches)
E_{tube}	Modulus of elasticity of tube (31.7 x 10^6 psi @ room temperature)

Thus, the adjustment for primary pressure, Δd_P, = [b] inches was [b] to the tubesheet bore dilation applied during tests performed with internal pressure (leak tests) to achieve the differential dilation for the test.

5.1.4.2 Primary Temperature Adjustment

As the temperature increases, the tube-to-tubesheet interference fit is [b] due to the reduction in the tube modulus of elasticity. The installed diametrical interference fit of [b], defined by previous testing, was adjusted by the ratio of the tube modulus of elasticity at room temperature to the tube modulus of elasticity at the transient temperature as shown in Equation 2.

Equation 2 Dilation Correction for Temperature

$$\Delta d_T = (1 - \frac{31.7 \times 10^6}{E_{transient}}) \times [\quad b \quad] inches$$

For each transient temperature condition, Equation 2 was used to determine the necessary differential dilation adjustment, Δd_T. The transient radial and circumferential differential dilations were then [b] by the transient temperature correction value.

An axial load of [b] was conservatively added to the faulted transient tube loads to account for dynamic tube loads associated with SSE. The dynamic tube loads associated with [b] occur early in the transient prior to the time of maximum tube loads. The dynamic tube loads associated with the [b] transient also occur early in the transient prior to the time of maximum tube loads and [b].

The [c] was analyzed after the development of the test cases; therefore, this transient was not included in the development of the test cases. However, the test results were applied to the results of this transient analysis and differential dilations that were not bounded by the test cases result in an exclusion zone.

The test loads were corrected to account for testing at room temperature. As the primary temperature increases, the yield strength of the tubing decreases] and the load carrying capability of the rolled joint may be [b]. Equation 3 shows the temperature correction.

Equation 3 Load Correction for Temperature

[b]

where T is the transient temperature (°F) and ΔL_T is the load adjustment factor. The applied test load = Transient Load x ΔL_T.

5.2 Single [e] Repair Roll Testing

5.2.1 Mockup Block and Test Samples

Cruciform blocks, which allow for simulation of tubesheet bore dilations by applying a biaxial load to the block, were used as a tubesheet mockup. The cruciform blocks were fabricated of material that is representative of the OTSG tubesheets. For testing, the block was mounted in a frame with hydraulic jacks mounted in both the vertical (y) and horizontal (x) axes to place dilation loads on the mockup block as shown in Figure 5-1.

The tube samples were [e] SB-163 alloy 600 tubing that were conservatively representative of OTSG tubing (See Section 5.1.3). One [e] yield tube was tested and the results are provided for information, but were not included in the qualification of the repair roll.

Because it was not possible to measure tubesheet bore dilations at the center of the cruciform block or the roll joint after the repair roll was installed, the blocks were calibrated to verify that the tubesheet bore dilations were the same at the primary face of the block as at the center of the block. Calibration loads were applied to the cruciform block and the resulting dilations at the primary face and the center of the block were recorded. The

calibration loads resulted in representative test dilation configurations, taking care not to yield the cruciform block.

Figure 5-1 Mounted Cruciform Test Block

[b]

5.2.2 Tube Installation and Mockup Conditioning

The tubesheet block and tubes were oxidized prior to tube installation to more closely represent the existing OTSG condition. Tubes were installed using the DELTA roll tool with a target torque [e]. The minimum acceptable torque for a single repair roll is [e]. [e] was used for lubrication, which is consistent with the field installation procedure. The roll expander roller design provided a [e] effective roll. The tubes were roll expanded using a spacer such that there was no heel transition in the tested repair roll, representing a complete circumferential sever at the end of the [e] effective roll (primary side). This configuration is conservative for leakage and slip because typical degradation in the repair rolls is represented by short axial cracks. After tube installation, the blocks were thermally cycled between 100°F and 635°F for [b] 3 to 6 hour cycles. The thermal cycles represent the effects of [b] heat-up and cooldown cycles.

Previous testing indicates that additional relaxation after [b] cycles is minimal.

5.2.3 Leak Tests

The purpose of the leak testing was to quantify leak rates for repair rolls for accident conditions. As noted above, the tested condition did not take credit for the heel transition, representing a full circumferential sever at the end of the [e] effective roll (primary side).

[c]

5.2.4 Slip Tests

The purpose of the slip tests was to verify that the repair roll could withstand axial loads [e]. As noted above, the tested condition did not take credit for the heel transition, representing a full circumferential sever at the end of the [e] effective roll (primary side). Applicable tubesheet bore dilations were achieved and an axial load was applied using a swage-lock fitting or an ID gripper attached to the free end of the tube. Tube movement was monitored during the test and verified by measuring the depth of the tube end after each test.

5.2.5 Test Matrix

As described above, the transient analyses data was reviewed and bounding differential dilations and axial loads were identified to develop a test matrix. Tubesheet bore dilations, radial and circumferential define each test case as shown in Table 5-1. The test matrix includes a set of applied loads for each slip test case and a combination of internal pressure and applied load for leak tests. In general, the [b] test cases bounded the [c] transient and the [b] test cases bounded the [c] transient, the [c] transient, and the [c]transient for all the OTSGs.

All leak tests were performed with the maximum 2575 psig internal pressure. The pressure end cap load, which contributes to the axial tube load during leak tests must be added to the applied axial load for the total axial tube load. For a test pressure of 2575 psig and a nominal mockup bore area of

Table 5-2 Test Matrix

[d]

Notes:

1) N/A indicates no test required.

5.2.6 Test Sequence

The test sequence progressed from less severe conditions (tubesheet bore dilations and/or axial loads) to more severe conditions. The tests were performed on each block in sequence with "Low Load Slip Test Case 1" followed by "Low Load Leak Test Case 1" through the low load tests (Table 5-2). Then "High Load Leak Test Case 2" was performed followed by the sequence of high load leak tests. Then "High Load Slip Test Set 1" were performed for each dilation case, followed by "High Load Slip Test Set 2" and "High Load Slip Test Set 3".

When tube movement was noted, the initial sequence of tests was terminated for that sample. Post-slip leak tests were performed following slip of the repair roll, following the sequence of the initial leak tests.

For some samples, the test sequence was adjusted in order to obtain as wide a range of data as possible.

5.2.7 Test Results

The test data was compiled and summarized to develop slip and leak criteria to qualify installation of a repair roll on a plant-specific basis. The test results, Tables 5-3 through 5-8 are reported for differential dilations, not the tubesheet bore dilations used in the testing.

5.2.7.1 Slip Test Results

Table 5-3 provides a summary of the joint strength data. The test number refers to the test case dilation set from Table 5-1 with the tubesheet bore dilations adjusted to tubesheet differential dilations as described in Section 5.1.4. "LS" indicates a low load slip test, "LL" indicates a low load leak test, "HL" indicates a high load leak test, and "HS" indicates a high load slip test. Other tests were added as noted to obtain additional bounding data where needed. The joint strength results column provides the number of samples tested at the target conditions and the number of samples that slipped with the load at which slip occurred.

Table 5-4 provides a summary of the slip data. The slip load is provided for each test block with the differential dilations. The roll torque for the repair roll is provided for information.

The results in Table 5-4 shows an outlying test sample that slipped at [d] for differential dilations of [d]. The target load for this test was [d] and the load was overshot. Two other samples were tested at this dilated condition; one slipped at [d] and one slipped at [d]. Another sample slipped at [d] for differential dilations of [d]. The [d] slip load may have been due to the presence of lubricant on the tube OD, but no residual was found on inspection. Since no justification for discarding the outlying data point could be verified; [d] was taken as the limiting load at this dilation even though it appears to be very conservative. Therefore, the

limiting load of [d] was applied to locations with a major dilation between [d] and a minor dilation less than or equal to [d].

As shown in Table 5-4, the minimum slip load for cases with a major dilation less than [d] was [d] for test block C-237-5 at differential dilations of [d]. The average slip load for these cases was [d] with a standard deviation of [d]. A limiting slip load of [d] was applied to all locations with a major dilation less than [d] with a minor dilation less than [d] or with major and minor dilations less than [d].

Table 5-3 Summary of Joint Strength

[d]

Table 5-3 Summary of Joint Strength (con't)

[d]

Table 5-3 Summary of Joint Strength (con't)

[d]

Table 5-4 Slip Data

[d]

5.2.7.2 Leak Test Results

The leak test data was used to establish leak rates to be applied to repair rolls. The bounding leak rates were developed based on the tests performed on effective [e] single repair rolls and may be conservatively applied to overlapping repair rolls.

Table 5-5 and Figure 5-2 provides a summary of the leak test results based on average dilation for low load leak tests and high load leak tests. These results apply to joints that are not predicted to slip under the applied axial load. [d]

Table 5-5 Average Low Load and High Load Leak Rates (No-Slip)

[d]

Note: N/A indicates no test was performed for this configuration.

Figure 5-2 Comparison of High Load and Low Load No-Slip Leak Rates

[d]

As shown in Table 5-5 and Figure 5-2, the no-slip leak rates [d] with loads and/or differential dilations. Therefore, a 1-sided 95% upper confidence limit (UCL) was calculated by [d] the test data as shown in Table 5-6. The result was [d].

Table 5-6 MSLB Leak Rates for No-Slip Condition Repair Rolls

[d]

The leak rate for the [b] was calculated by multiplying the [d] leak rates by the square root of the ratio of the pressure differentials, based on a deterministic model for leakage from an axial crack (EPRI NP-6864-Rev.2). The maximum pressure differential during the [c] transient is [c] and occurs [c] to the time of maximum load (approximately [c] minutes into the transient). The pressure differential during the [c] at the time of maximum load (approximately [c] into the transient), then continues to [c] after the time of maximum load. The tube-to-shell temperature difference at the time of maximum pressure is approximately [c] temperature difference at the time of maximum load. Thus, if the tube does not slip at the time of maximum load, it is [c] that it would slip at the time of maximum pressure. Since the [c] no-slip leak rate for [c] is bounded by the [c] no-slip leak rate, the leak rate for the [c] is calculated for the time of maximum load for post-slip leakage.

Thus, the leak rate (LR) for the [c] is calculated as:

[c]

Leak tests were performed for additional information for 2 test blocks with dilations of [d] at [d] internal pressure and [d]. The average leak rate at [d] was [d]. The average leak rate at [d] was [d]. The results of these leak tests provide confirmation that calculating a leak rate for the [c] using the ratio of the square root of the pressure differentials is a valid approach.

Repair roll leakage during normal operation is predicted using the ratio of the square root of the pressure differentials. The pressure differential at steady-state 100% power is 1275 psi as presented in Table 4-1. Thus, the predicted steady-state operation leak rate is [d] for each repair roll that serves as a pressure boundary. Leakage is monitored during steady-state operation and the plant is shut down if the leakage exceeds the technical specification limits. The steady-state leak rate is provided to provide assurance that the total leakage from repair rolls would not result in leakage that would require the plant to be shut down.

Post-slip leak tests were performed to establish a bounding leak rate for all tubes that are predicted to slip. The results are provided in Table 5-7 and Figure 5-3. Again, the leak rate is [d] by the internal pressure and [d] considerably with [d] as shown in Figure 5-3. Therefore, the [d] post-slip leak rate is applied to all locations where the repair roll may potentially slip.

Table 5-7 Post-Slip Condition Leak Test Results

[d]

Note: N/A indicates no test was performed for this configuration.

Binning [d] the post-slip leak data [d], the [d] post-slip leak rate for a repair roll is [d].

The application of repair rolls leak rates described above is a very conservative approach because only repair rolls with large circumferential cracks will actually slip and the majority of the degradation in the tubesheet are short, axial cracks. Therefore, the probability of maintaining structural integrity between the new roll and the tube-to-tubesheet weld is very high and the potential for a joint to slip is very low. In addition, leak rates from short axial cracks would be much lower under tensile loads than the circumferential sever that was tested. Thus, the applied leak rates are conservative whether the repair roll slips or not.

The leak rate from each single repair roll or overlapping repair roll that is serving as a pressure boundary is summed to obtain a total leak rate for the OTSG. Plant-specific total leakage would vary depending on the total number of repair rolls and the number of repair rolls that could potentially slip.

Figure 5-3 Comparison of High Load and Low Load Post-Slip Leak Rates

[d]

5.2.8 Conclusions

Table 5-8 provides the bounding differential dilations and loads used to predict repair rolls that may potentially slip. The term Δd refers to the differential dilation from the transient analyses after normalization to room temperature. The room temperature leak rates to be applied to repair rolls are provided in Table 5.9. The application of the slip criteria and leak rates is discussed further in Sections 6.0 and 7.0 respectively.

Table 5-8 Repair Roll Slip Criteria

[d]

Table 5-9 Bounding Repair Roll Leak Rates (Room Temp.)

[d]

5.3 Overlapping Repair Rolls

For the overlapping roll, a second repair roll is installed that overlaps the first repair roll. Figure 2-1 provides a sketch of the repair rolls. The overlapping roll provides a minimum [e] effective roll expansion.

[b] of the tube due to repair roll installation can be minimized by the installing the [b] repair roll first, thereby overlapping the [b] transition of the first repair roll. However, the [b] roll can be installed first, followed by an [b] roll or a [e] roll expansion can be installed

that overlaps an existing repair roll. The [d] transition may be eliminated by installing an [b] repair roll first, followed by installing overlapping [d] repair rolls [b].

The joint strength increases with the overlapping repair roll, due to the [b]. Leakage would be less since the pressure differential would be the same, but friction losses through the longer leak path would be increased. The leak and load testing of a [e] single repair roll conservatively bounds overlapping repair rolls. The [e] single repair roll leak rates may be conservatively applied to the overlapping repair rolls for evaluation purposes.

6.0 Repair Roll Exclusion Zones

A repair roll exclusion zone is a location where installation of a repair roll has not been qualified. An exclusion zone may be generic, which is applied to all OTSGs, or specific to a particular plant.

6.1 Generic Exclusion Zones

Generic exclusion zones for the repair rolls are applied within the first [d] from the primary and secondary faces of the tubesheets. These generic exclusion zones ensure that the following repair roll design requirements are met:

- The repair roll is remote from the original roll expansion.
- The tube will not slip out of the tubesheet.

An exclusion zone of [e] from the tubesheet primary face conservatively ensures that a repair roll will be remote from the original [e] roll expansion.

An exclusion zone of [e] from the tubesheet secondary face ensures that tube will not slip out of the tubesheet. The maximum axial tube load for the OTSGs is [c]. Assuming 100% of the strain is relieved, the axial deflection due to this load is:

$$\delta = \frac{PL}{EA}$$

Where: P is the axial tube load = [c]

L is the tube length = [b]

E is the modulus of Elasticity = [b]

A is the nominal OTSG tube area = [b]

[b]

Therefore, an exclusion zone of [e] from the secondary face ensures that the tube will not slip out of the tubesheet.

Thus, generic exclusion zones of [e] from the primary and secondary faces of the tubesheets are applied to all OTSGs.

6.2 Plant-Specific Exclusion Zones

The repair roll design requires that tube failure does not result from tube bow [c] conditions. Tube buckling under subsequent heatup from decay heat is

bounded by the [c] loads during a normal operating [c]. If the tube slips during a faulted accident, it is unlikely the tube will slip back into its original location. If the tube slips, a tube could potentially bow between tube support plate locations at the end of the faulted accident due to compressive loads caused by decay heat. As calculated above, the maximum amount of tube slip is approximately [b] over the length of the tube due to the bounding axial tube load. The total slippage of [b] would be distributed over the length of the tube [b]. The tube-to-shell temperature differential and resulting compressive loads due to heatup from decay heat would be much less than the temperature differential due to a normal [c]. Thus, post-slip tube buckling due to decay heat would be bounded by the normal [c] compressive loads prior to slip. Therefore, no plant-specific exclusion zones are required based on post-faulted transient tube bow.

The differential dilations from the FE transient analyses results for each plant were evaluated based on the criteria presented in Table 5-8 to determine plant-specific exclusion zones for the repair roll. The following bounding conditions were evaluated:

[c]

The criteria presented in Table 5-8 were applied to each tubesheet depth and radial position to determine if the differential dilations are within the tested parameters and if there is a potential for repair roll slip under normal operating conditions. Differential dilations that are greater than [d] for any transient resulted in an exclusion zone simply because test data is not available for differential dilations greater than [d]. In many cases, the criteria may result in conservative exclusion zones. The limiting differential dilations were typically due to [c] and the limiting dilation

was a minor dilation of [d]. Since the repair roll [e] and leakage under [c] would be minimal for most of the transient due to the [d] pressure differential (See Section 4-4 and Figure 4-3), this is a conservative approach.

Potential repair roll slip during a [c] transient resulted in an exclusion zone because the repair rolls are [c]. None of the plant-specific exclusion zones (provided in the Appendices) were the result of potential slip of a repair roll during a [d] transient.

Appendices A through D provide figures of the Exclusion Zones as a function of tubesheet depth and radial position.

7.0 Application of Leak Rates

Based on evaluations of differential dilations and loads for the bounding faulted conditions for each plant (See Section 6.0), potential slip of the repair roll was determined as a function of tubesheet depth and radial position. Margin against slip was calculated for each tubesheet depth and radial position.

The bounding applicable no-slip leak rate (Table 5-9) was applied to locations identified as having no potential for repair roll slip.

A bounding applicable post-slip leak rate was applied to locations that may result in repair roll slip. The bounding leak rate is applied to the entire transient time, which is a conservative approach since the maximum pressure differential typically occurs late in the transient. In the case of the [c], the maximum pressure differential occurs [c] in the transient and [c] with time.

The repair roll will actually slip only if there is a circumferential flaw that is large enough in extent to prevent the tube-to-tubesheet weld from carrying any of the load. Since the majority of the degradation in the region of the roll joints has been identified as small axial cracks, the probability of the repair roll maintaining structural integrity is very high. Application of only a non-slip leak rate may be used if the tube is inspected full length, including the region of tube outside of the new pressure boundary and the tube-to-tubesheet weld transition region, to verify that there are no limiting circumferential cracks present.

As described in Section 5.2.7, the applied leak rates are very conservative since the tests were performed on samples with a full circumferential sever outboard of the repair roll. The majority of degradation in the tubesheet are short, axial cracks which result in a much lower leak rate under tensile loads than the tested circumferential cracks.

The leakage from each repair roll that serves as a pressure boundary is added to the total leakage from all other sources and must be below the technical specification limits.

8.0 Non-Destructive Examination of Repair Rolls

Repair roll candidates are identified by EC inspection of the OTSG tubes. ET methods may vary from plant to plant and may change as improved methods are made available. In general, adherence to the EPRI Guidelines for ET tube inspections is recommended. The acceptability of an ET method of inspection for repair roll installation is based on the following requirements.

8.1 Pre-Repair Roll

The following ET information for repair roll candidates shall be established as a minimum base line:

1) Generator, Channel Head, Tube Row and Tube Column must be defined.
2) Pull speeds and frequencies shall be in accordance with plant Steam Generator Eddy Current Data Analysis Guidelines and/or other applicable plant-specific documents.
3) Location of the tip of the indication of degradation furthest from the primary face of the tubesheet.

8.2 Post-Repair Roll

The following ET information for repair rolls shall be collected as a minimum:

1) Generator, Channel Head, Tube Row and Tube Column
2) Pull speeds and frequencies shall be in accordance with plant Steam Generator Eddy Current Data Analysis Guidelines and/or other applicable plant-specific documents.
3) Profile of new tube ID (absolute or relative), including the new inside diameters of the hard-rolled section of the tube, inside diameter of original hard roll, and the nominal unexpanded tube ID.
4) Verify that the effective repair roll is free of defect indications.

9.0 Repair Roll Installation Parameters

The design parameters for a field implemented repair roll joint are as follows:

(a) A minimum [e] effective repair roll remote from existing defects and previous roll transitions.

(b) An optional overlapping repair roll, with a minimum [e] of new effective roll remote from existing defects.

(c) An installation torque of [e] using a qualified repair roll process tool assembly (e.g. DELTA tool).

(d) Installation no closer than [e] from the primary and secondary tubesheet faces.

(e) Repair rolls are not qualified at locations shown as exclusion zones in Appendices A through D.

(f) [b] single [b] repair rolls or [b] overlapping repair roll that results in a maximum of [b] additional [b] load may be installed at a qualified location in any one tube. Additional repair rolls may be installed on a case-by-case basis by evaluating for acceptable [b] tube loads.

10.0 Conclusions

This evaluation has shown that installation of a single [e] repair roll or a [e] overlapping repair roll in the OTSGs is acceptable based on the following:

Structural Integrity

The single [e] minimum repair roll is structurally adequate to prevent tube slip during all [e] transients. [e].

The qualification is valid for locating the roll expansion in the OTSGs with the exception of the generic [e] exclusion zones at each face of the tubesheet, primary and secondary, and the plant-specific exclusion zones identified in Appendices A through D. The plant-specific exclusion zones may be conservative in that application of these exclusion zones was based on the limitations of the test equipment for differential dilations greater than [d]. Many of the locations that resulted in an exclusion zone experience differential dilations that are only slightly greater in the minor dilation ([d]) with a major dilation less than [d].

An optional [e] minimum overlapping roll is structurally acceptable based on the bounding evaluation of the single [e] repair roll.

The repair roll is applicable to repairing axial, volumetric, or circumferential indications. Testing was conservatively performed with the assumption that the tube is severed at the heel transition (360° and 100% through-wall circumferential defect).

The joint strength margin (actual load / limiting load) was calculated for each tubesheet depth and radial position for the [c] transient to ensure margin against slip for [c] conditions. All locations showed a joint strength margin less than [e] with an acceptable margin less than 1.0.

Leakage

Bounding leak rates are applied based on tubesheet depth and radial position. A post-slip leak rate is applied to any location where there is potential for repair roll slip during a [c]. The bounding leak rates are very conservative because the leakage is based on test samples with a full circumferential sever outboard of the repair roll. The majority of the degradation in the tubesheets is short, axial cracks for which the leakage would be much less under axial tensile loads than for the tested severed tube. In addition, repair rolls will actually slip only if there is a large circumferential crack present in the tube outboard of the repair roll.

It may be desirable in some cases to further limit the number of repair rolls that are predicted to slip; thereby avoiding the application of the post-slip leak rates. Application of only a non-slip leak rate may be used if the tube is inspected full length, including the region of tube outside of the new pressure boundary and the tube-to-tubesheet weld transition region, to verify that there are no limiting circumferential cracks present.

The leakage from each repair roll that serves as a pressure boundary is added to the leakage from all other sources and the total leakage must be within the technical specification limits.

Conservatism Elements (Analyses and Testing)

Conservative elements in the qualification of the repair roll included, but were not limited to the following:

Transient Analyses (General)

1) The worst case geometrical configurations and/or dimensions were used to develop the differential dilations and axial tube loads. The configuration and/or dimensions that resulted in the highest axial loads were used in the transient analyses.

[c] Transient Analyses:

2) Secondary side water level was maintained at [b] during the entire transient, increasing tube-to-shell temperature difference.
3) No credit was taken for direct impingement of main feedwater on the inside shell surface, increasing tube-to-shell temperature difference.
4) Natural convection of water for the entire feedwater downcomer was assumed, increasing tube-to-shell temperature difference.

[c] Transient Analyses:

5) A maximum value for the Initial OTSG secondary inventory was used to bound plant operation.
6) Main feedwater isolation valve actuation and stroke times are maximized to bound actual operation in the plant.
7) Maximum safety injection flow rates were used to bound plant characteristics and maximize RCS cooling.
8) Safety injection actuation delay times were zero.
9) Nominal control rod worth was inserted (no stuck rod penalty)
10) Used maximum AFW flow and minimum AFW temperature to the affected OTSG for 10 minutes (where applicable).
11) ONS-Specific MSLB: Used operator action at two minutes to trip the Reactor Coolant Pumps, which maximizes Reactor Coolant System cooldown.

[c] Transient Analyses:

12) Limiting break selection:

   a) The break is large enough to depressurize the plant to obtain actuation of the low pressure safety injection. This low temperature water eventually flows back to the OTSG tubes.

   b) The break is small enough that a two-phase discharge through the break occurs with liquid from the vessel region and steam provided from the OTSG. Venting steam from the OTSG tubes allows the tubes to be "wetted" over their entire length with relatively cold, two-phase reactor coolant.

   c) The break is at an elevation above the RC pump spill-over elevation such that the hot-leg-to-steam generator manometer effect allows cold LPI fluid to flow backwards from the reactor vessel, through the RC pump, into the cold leg suction piping, and eventually in the OTSG.

[c] Break:

13) One hundred percent decay heat was modeled.

14) Maximum emergency core cooling system (ECCS) flow from all pumps was modeled to maximize the cold water addition to the RCS and minimize and tube temperature.

15) Minimum ECCS flow actuation delays were modeled to maximize the addition of cold ECCS fluid to the RCS.

16) ECCS fluid temperature was set to a minimum value to maximize the cooling of the OTSG tubes when this fluid enters the OTSG tubes.

[c] Break:

17) Ninety percent decay heat was modeled.

18) Maximum emergency core cooling system (ECCS) flow from all pumps, including the makeup pumps, was modeled to maximize the cold water addition to the RCS and minimize and tube temperature.

19) Minimum ECCS flow actuation delays and maximum setpoint pressures were modeled to maximize the addition of cold ECCS fluid to the RCS.

20) The CFT fluid conditions were set to allow CFT injection at the earliest time.

21) ECCS and CFT fluid temperatures were set to a minimum value to maximize the cooling of the OTSG tubes when this fluid enters the OTSG tubes.

22) The steam generator shell was modeled as an adiabatic boundary condition to minimize heat losses from the shell.

Repair Roll Testing:

23) Test conditions were selected to bound the worst case combination of joint structural strength and/or leakage, [b].

24) Leak tests were performed at the maximum possible pressure differential of 2575 psig, derived from the safety relief valve setpoint and assuming no operator intervention.

25) A full circumferential sever was modeled for the testing, which is conservative for structural strength and leakage since the majority of the degradation within the tubesheet is short, axial cracks. The model assesses the joint strength of a repair roll without taking any credit for the original roll expansion or the tube-to-tubesheet weld. The tested configuration results in very conservative leak rates since leakage for short axial cracks under tensile loads would be much less than the tested circumferential sever.

26) Leak rates were developed based on static testing with axial loads and differential dilations constant throughout the 20-minute leak test.

Exclusion Zones:

27) An exclusion zone of [e] from the secondary face is conservative since the maximum possible slippage is approximately [b] .

28) An exclusion zone of [e] from the primary face is conservative to ensure that a repair roll is remote from the original [e] roll expansion.

29) Plant-specific exclusion zones were based on maximum differential dilations of [d]. Many of the plant-specific exclusion zones were due to a [c] minor dilation of [d] with a major dilation of less than [d]. Even though these dilations were not tested, the leakage due to these [c] conditions would probably be minimal.

Applied Leak Rates:

30) Bounding no-slip leak rates were developed by calculating a 1-sided 95% UCL limit.

31) The bounding leak rates, [d] are assumed to be constant for the entire transient, even though the maximum pressure differential occurs [c] in the transient for the [c] and for only [c] of the [c].

32) A post-slip leak rate was applied to all repair rolls that have the potential to slip, regardless of whether a circumferential crack is actually present. The repair roll will not actually slip unless a large circumferential flaw is present. As described above, since the majority of the degradation within the tubesheet is short, axial cracks. Application of only a no-slip leak rate may be used if the tube is inspected full length, including the region of tube outside of the new pressure boundary and the tube-to-tubesheet

weld transition region, to verify that there are no limiting circumferential cracks present. The no-slip leak rate is this case would still be conservative as described above in item 18.

All repair rolls installed under previous submittals meet the repair roll qualifications of this topical report.

Appendix A Exclusion Zones and Repair Roll Leak Rates for ANO-1

The limiting condition for ANO-1 repair roll slip is the [c], primarily due to minor dilations greater than [d]. These locations result in an exclusion zone because the condition has not been tested. [e].

For the UTS at ANO-1, a repair roll can be placed with the roll centerline between [e] tubesheet depth at any radial position with a leak rate of [d] applied to each repair roll that serves as a pressure boundary. Additional qualified locations are shown in Figure A-1.

For the LTS at ANO-1, a repair roll can be placed with the roll centerline between [e] at any radial position with a leak rate of [d] applied to each repair roll that serves as a pressure boundary. Additional qualified locations are shown in Figure A-2.

The predicted leakage at steady-state 100% power conditions from each repair roll that serves as a pressure boundary is [d].

All repair rolls installed under previous submittals meet the repair roll qualifications of this topical report.

Figure A-1 ANO-1 Upper Tubesheet Exclusion Zones

[d & e]

Figure A-2 ANO-1 Lower Tubesheet Exclusion Zones

[d & e]

Appendix B Exclusion Zones and Repair Roll Leak Rates for CR-3

The limiting condition for CR-3 repair roll slip is the [c], primarily due to minor dilations greater than [d]. These locations result in an exclusion zone because the condition has not been tested. [e]

For the UTS at CR-3, a repair roll can be placed with the roll centerline between [e] tubesheet depth at any radial position with a leak rate of [d] applied to each repair roll that serves as a pressure boundary. Additional qualified locations are shown in Figure B-1.

For the LTS at CR-3, a repair roll can be placed with the roll centerline between [e] at any radial position with a leak rate of [d] applied to each repair roll that serves as a pressure boundary. Additional qualified locations are shown in Figure B-2.

The predicted leakage at steady-state 100% power conditions from each repair roll that serves as a pressure boundary is [d].

All repair rolls installed under previous submittals meet the repair roll qualifications of this topical report.

Figure B-1 CR-3 Upper Tubesheet Exclusion Zones

[d & e]

Figure B-2 CR-3 Lower Tubesheet Exclusion Zones

[d & e]

Appendix C Exclusion Zones and Repair Roll Leak Rates for DB-1

The limiting conditions for DB-1 repair rolls vary with depth and radial position. The limiting conditions are [c]. For both transients, a minor dilation greater than [d] results in an exclusion zone because the condition has not been tested. [e].

For the UTS at DB-1, a repair roll can be placed with the roll centerline between [e] tubesheet depth at any radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. Additional qualified locations are shown in Figures C-1

See Figure C-2 for qualified repair roll locations and applicable leak rates for the LTS at DB-1.

The predicted leakage at steady-state 100% power conditions from each repair roll that serves as a pressure boundary is [d].

There are no previously installed repair rolls in service at DB-1. The four repair rolls that were installed under previous submittals have been plugged.

Figure C-1 DB-1 Upper Tubesheet Exclusion Zones

[d &e]

Figure C-2 DB-1 Lower Tubesheet Exclusion Zones

[d & e]

Appendix D Exclusion Zones and Repair Roll Leak Rates for Oconee (ONS-1, ONS-2, and ONS-3)

The limiting conditions for ONS-1 repair roll slip are the [c], primarily due to minor dilations greater than [d]. These locations result in an exclusion zone because the condition has not been tested. [e].

For the UTS at ONS, a repair roll can be placed with the roll centerline between [e] tubesheet depth at any radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. Additional qualified locations are shown in Figure D-1.

For the LTS at ONS, a repair roll can be placed with the roll centerline between [e] tubesheet depth at any radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. A leak rate of [d] shall be applied to each repair roll that serves as a pressure boundary from [e] radial position. Additional qualified locations are shown in Figure D-2.

The predicted leakage at steady-state 100% power conditions from each repair roll that serves as a pressure boundary is [d].

All repair rolls installed under previous submittals meet the repair roll qualifications of this topical report.

Figure D-1 ONS Upper Tubesheet Exclusion Zones

[d & e]

Figure D-2 ONS Lower Tubesheet Exclusion Zones

[d&e]

Environmental Evaluation

The FirstEnergy Nuclear Operating Company (FENOC) has determined that the proposed amendment would change requirements with respect to the installation or use of a facility component located within the restricted area, as defined in 10CFR20, or would change an inspection or surveillance requirement. FENOC has evaluated the proposed changes and has determined that the changes do not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amount of effluent that may be released offsite, or (iii) a significant increase in the individual or cumulative occupational radiation exposure. Accordingly, the proposed change meets the eligibility criterion for categorical exclusion set forth in 10CFR51.22 (c)(9). Therefore, pursuant to 10CFR51.22 (b), an environmental assessment of the proposed change is not required.

Docket Number 50-346
License Number NPF-3
Serial Number 2705
Enclosure 2

**PROPOSED TECHNICAL SPECIFICATION CHANGES
REVISION BAR FORMAT**

(3 Pages Follow)

2. A seismic occurrence greater than the Operating Basis Earthquake.

3. A loss-of-coolant accident requiring actuation of the engineered safeguards.

4. A main steam line or feedwater line break.

d. The provisions of Specification 4.0.2 are not applicable.

4.4.5.4 Acceptance Criteria

a. As used in this Specification:

1. Tubing or Tube means that portion of the tube or tube sleeve which forms the primary system to secondary system boundary.

2. Imperfection means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

3. Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.

4. Degraded Tube means a tube containing imperfections ^{3} 20% of the nominal wall thickness caused by degradation that has not been repaired by repair roll or sleeving in the affected area.

5. % Degradation means the percentage of the tube wall thickness affected or removed by degradation.

6. Defect means an imperfection of such severity that it exceeds the repair limit. A defective tube is a tube containing a defect that has not been repaired by repair roll or sleeving in the affected area or a sleeved tube that has a defect in the sleeve.

7. Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or repaired by repair roll or sleeving in the affected area because it may become unserviceable prior to the next inspection and is equal to 40% of the nominal tube wall thickness. The process described in Topical Report BAW-2120P will be used for sleeving.

SURVEILLANCE REQUIREMENTS (Continued)

(Continued) 7. The repair roll process used is described in the Topical Report BAW-2303P, Revision 4. The new roll area must be free of degradation in order for the repair to be considered acceptable.

8. Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 4.4.5.3.c, above.

9. Tube Inspection means an inspection of the steam generator tube from the point of entry completely to the point of exit. The previously existing tube and tube roll, outboard of the new roll area in the tube sheet, can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed.

operation and by postulated accidents. Operating plants have demonstrated that primary-to-secondary leakage of 150 GPD can be detected by monitoring the secondary coolant. Leakage in excess of this limit will require plant shutdown and an unscheduled inspection, during which the leaking tubes will be located and plugged or repaired by repair rolling or sleeving in the affected areas.

Wastage-type defects are unlikely with proper chemistry treatment of the secondary coolant. However, even if a defect should develop in service, it will be found during scheduled inservice steam generator tube examinations. As described in Topical Report BAW-2120P, degradation as small as 20% through wall can be detected in all areas of a tube sleeve except for the roll expanded areas and the sleeve end, where the limit of detectability is 40% through wall. Tubes with imperfections exceeding the repair limit of 40% of the nominal wall thickness will be plugged or repaired by repair rolling or sleeving the affected areas. Davis-Besse will evaluate, and as appropriate implement, better testing methods which are developed and validated for commercial use so as to enable detection of degradation as small as 20% through wall without exception. Until such time as 20% penetration can be detected in the roll expanded areas and the sleeve end, inspection results will be compared to those obtained during the baseline sleeved tube inspection.

An additional repair method for degraded steam generator tubes consists of rerolling the tubes in the tubesheet to create a new roll area and pressure boundary for the tube. The repair roll process will ensure that the area of degradation will not serve as a pressure boundary, thus permitting the tube to remain in service. The degraded area of the tube can be excluded from future periodic inspection requirements because it is no longer part of the pressure boundary once the repair roll is installed in the tubesheet.

All tubes which have been repaired using the repair roll process will have the new roll area inspected during the inservice inspection. Defective or degraded tube indications found in the new roll area as a result of the inspection of the repair roll and any indications found in the originally rolled region of the rerolled tube need not be included in determining the Inspection Results Category for the general steam generator inspection.

The repair roll process will be performed as described in the Topical Report BAW-2303P, Revision 4. The new roll area must be free of degradation in order for the repair to be considered acceptable. After the new roll area is initially deemed acceptable, future degradation in the new roll area will be analyzed to determine if the tube is defective and needs to be removed from service. Leakage from repair rolls will be accounted for to ensure post-accident primary-to-secondary leakage will not exceed that assumed in the safety analyses.

Docket Number 50-346
License Number NPF-3
Serial Number 2705
Enclosure 3

COMMITMENT LIST

THE FOLLOWING LIST IDENTIFIES THOSE ACTIONS COMMITTED TO BY THE DAVIS-BESSE NUCLEAR POWER STATION (DBNPS) IN THIS DOCUMENT. ANY OTHER ACTIONS DISCUSSED IN THE SUBMITTAL REPRESENT INTENDED OR PLANNED ACTIONS BY THE DBNPS. THEY ARE DESCRIBED ONLY FOR INFORMATION AND ARE NOT REGULATORY COMMITMENTS. PLEASE NOTIFY THE MANAGER – REGULATORY AFFAIRS (419-321-8450) AT THE DBNPS OF ANY QUESTIONS REGARDING THIS DOCUMENT OR ANY ASSOCIATED REGULATORY COMMITMENTS.

COMMITMENTS	**DUE DATE**
None	N/A