I. OVERVIEW / SIGNATURES

Facility: Waterford 3

Document Reviewed: ER-W3-2004-0122-000 **Change/Rev.: 0**

System Designator(s)/Description: RC / Reactor Coolant

Description of Proposed Change

The W-3 pressurizer contains 30 heater sleeves, four top mounted instrument nozzles, one side mounted temperature nozzle, and two bottom mounted instrument nozzles. Top mounted instrument nozzles A and C were found leaking during RF-09 and they were repaired (ref. ER-W3-1999-0184-00) with new Alloy 690 nozzles using a partial nozzle weld repair. During RF-10 top mounted instrument nozzles B and D were also pro-actively repaired (ref. ER-W3-1999-0184-02) with new Alloy 690 nozzles using the partial nozzle repair design. In addition, during RF-09 heater sleeve F-4 (ref. ER-W3-1999-0184-07) was discovered to be leaking and it was repaired by removing the heater and installing an Alloy 690 welded plug. During Refuel 12 heater sleeves C-1 and C-3 were found to be leaking and they were temporarily repaired using the mechanical nozzle seal assembly (MNSA)-2 seal assembly (ref. ER-W3-2001-1211-00). During a design review performed in 2004 it was discovered that the repair of top mounted instrument nozzles A and C was inadvertently implemented utilizing filler metal that is susceptible to future Primary Water Stress Corrosion Cracking (PWSCC) (Ref. CR-W3-2004-4035).

ER-W3-2004-0122-000 authorizes the pre-emptive permanent weld repair of all thirty pressurizer heater sleeves, including the recovery of plugged heater sleeve F-4 and clamped heater sleeves C-1 and C-3. In addition, it authorizes the pre-emptive weld repair of the two bottom pressurizer instrument nozzles and one side shell temperature nozzle, and the re-welding of top mounted instrument nozzles A and C using PWSCC resistant filler metal. For twenty-nine of the heater sleeves the new mid-wall repair design will be used. The design removes the lower portion of the existing Alloy 600 sleeve and installs a new Alloy 690 sleeve. The remaining section (remnant) of Alloy 600 sleeve will remain in place. The RCS pressure boundary will be formed by this new mid-wall weld, by the Alloy 690 heater sleeve, and by the fillet weld between the heater sleeve and the heater. The configuration is shown in Figure 1 Section A-A. The repair of heater sleeves C-1 and C-3 previously repaired with the MNSA-2 will also use the mid-wall repair with a specially designed sleeve as shown in Figure 2 Section C-C.

The repair of heater sleeve F-4 will consist or removal of the welded plug and insertion of a new length of Alloy 690 sleeve material, J-groove welded to the existing O.D. weld metal pad as shown on Figure 2 Section D-D. The repair of the two bottom mounted instrument nozzles and the side shell temperature nozzle are shown in Figure 1 Section B-B, and Figure 3 Section A-A. The design also removes a portion of the existing Alloy 600 instrument nozzles, and installs a new Alloy 690 nozzle. In these cases, the nozzle will be J-groove welded to new weld pads which are installed on the outside surface of the vessel.

This ER also authorizes replacement of the existing Watlow pressurizer heaters with an improved design manufactured by a joint venture between Framatome and Thermocoax. The new heater is considered equivalent, having the same form, fit, and function as the existing heater. Watlow heaters have experienced a high failure rate throughout the industry and W3 has replaced 42 Watlow heaters in 19 years. Thermocoax reports approximately 4000 heaters in service since 1976, with only 15 reported failures worldwide in 19 years. Furthermore, Watlow is no longer improving their pressurizer heater design.

Figure 1 Sections Showing Heater Sleeve and Instrument Nozzle Repair

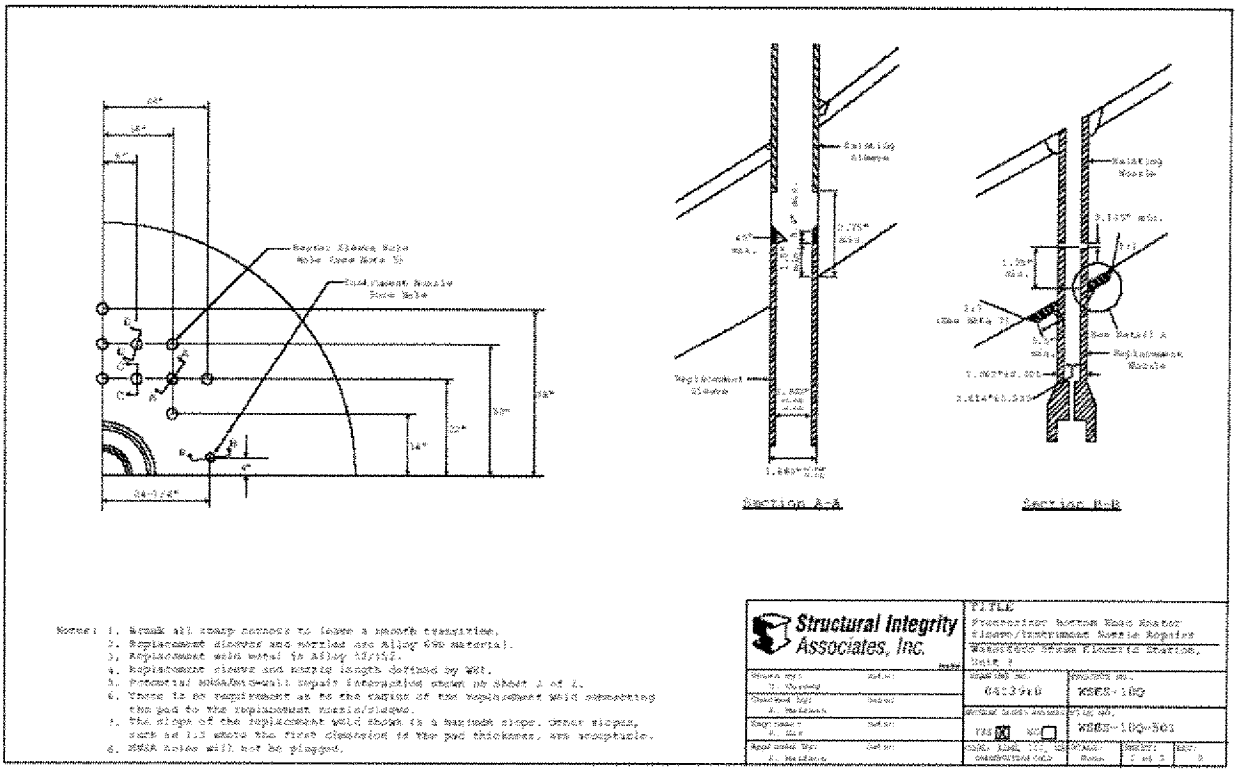


Figure 2 Sections Showing Heater Sleeve and Instrument Nozzle Repairs at Previous MNSA and OD Pad Locations

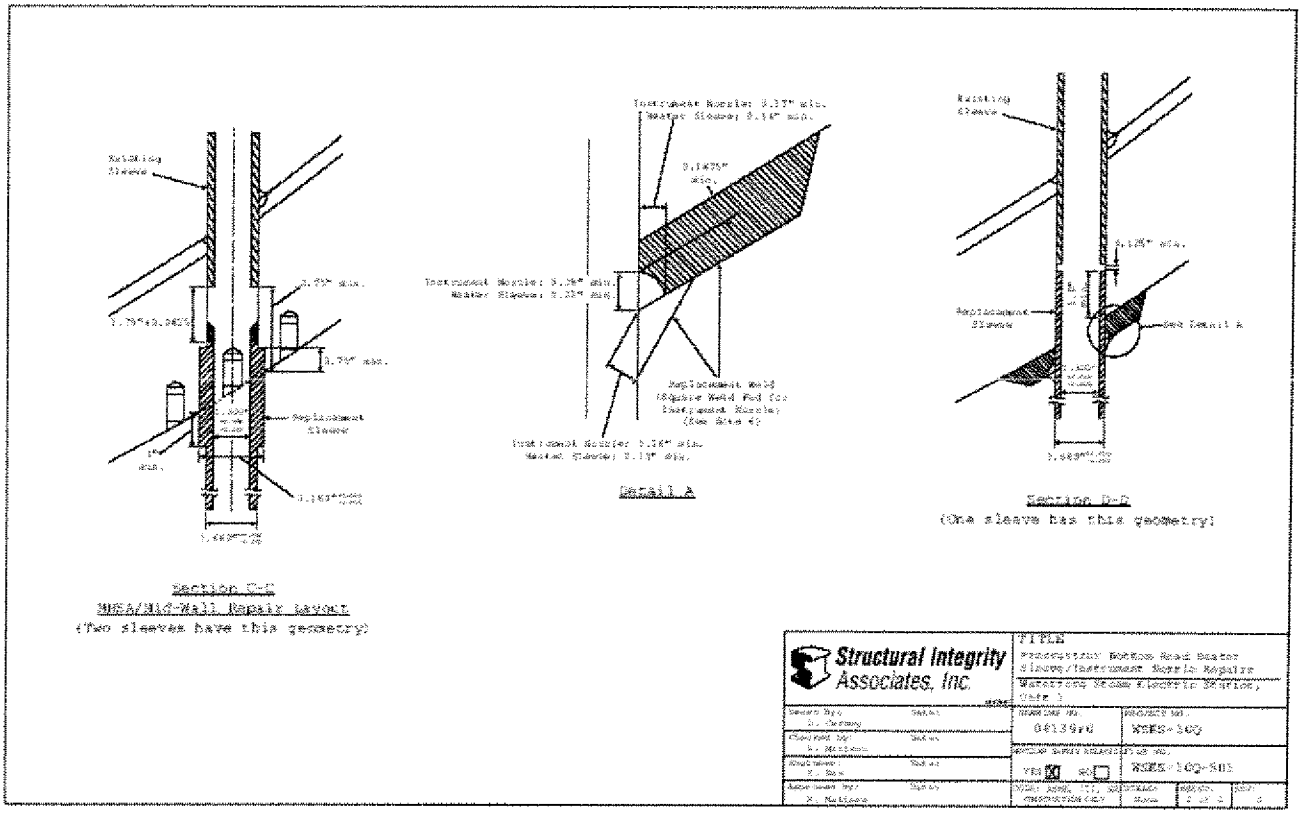
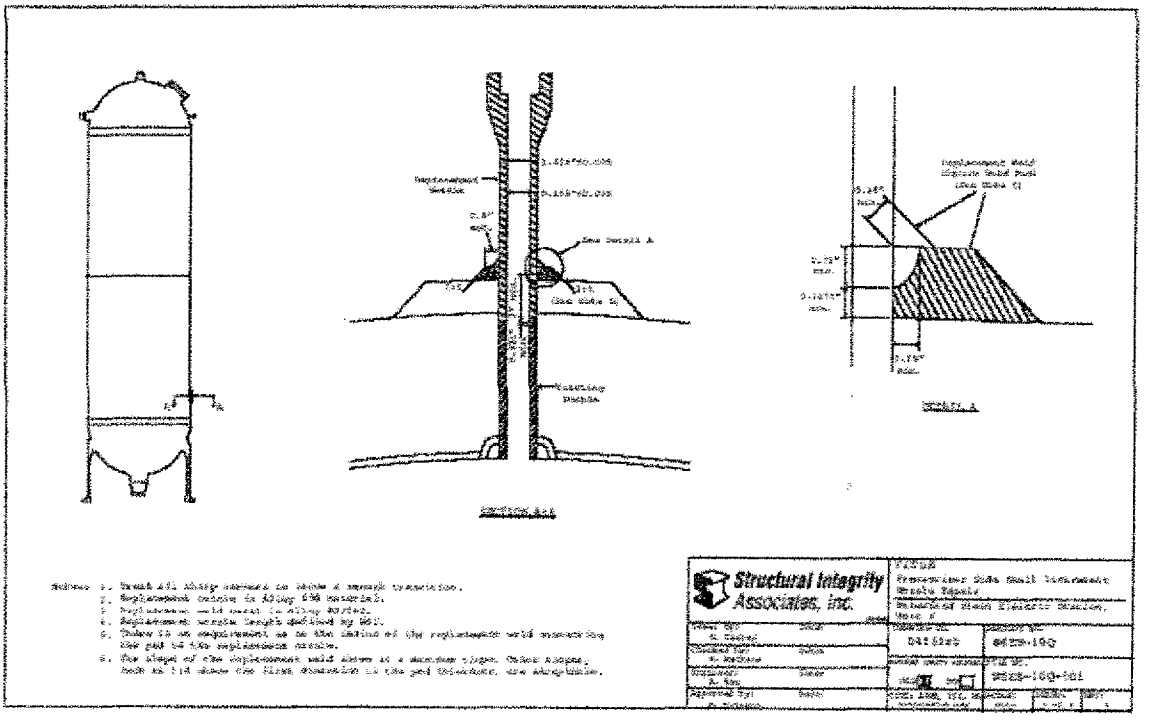


Figure 3 Section Showing Side Shell Instrument (Temperature) Nozzle Repair



NOTE: Figures 1, 2 and 3 are included for information only to show the design configuration.

Check the applicable review(s): (Only the sections indicated must be included in the Review.)

☐	**EDITORIAL CHANGE of a Licensing Basis Document**	**Section I**
☐	**SCREENING**	**Sections I and II required**
☐	**50.59 EVALUATION EXEMPTION**	**Sections I, II, and III required**
☒	**50.59 EVALUATION (#: 05 - 007)**	**Sections I, II, and IV required**

Preparer: Gary E. Payne / Gary E Payne / EOI / Project Management / 02-24-05
Name (print) / Signature / Company / Department / Date

Reviewer: Lawrence D. Theriault / (SEE ERD) / D. P. Engineering / Alloy 600 / 02-24-05
Name (print) / Signature / Company / Department / Date

OSRC: R. A. Dodds III / R Dodds 25 Feb 2005
Chairman's Name (print) / Signature / Date
[Required only for Programmatic Exclusion Screenings and 50.59 Evaluations.]

II. SCREENINGS

A. Licensing Basis Document Review

1. Does the proposed activity impact the facility or a procedure as described in any of the following Licensing Basis Documents?

Operating License	YES	NO	CHANGE # and/or SECTIONS IMPACTED
Operating License	☐	☒	
TS	☐	☒	
NRC Orders	☐	☒	
If "YES", obtain NRC approval prior to implementing the change by initiating an LBD change in accordance with NMM ENS-LI-113. (See Section 5.2[13] for exceptions.)			

LBDs controlled under 50.59	YES	NO	CHANGE # (if applicable) and/or SECTIONS IMPACTED
FSAR	☒	☐	DRN 04-1552; Table 5.2-3, Table 5.4-6, Section 5.4.3.2, Figure 5.4-6 DRN 04-1551; Figure 8.3-33, Table 8.3-1, Table 8.1-2
TS Bases	☐	☒	
Technical Requirements Manual	☐	☒	
Core Operating Limits Report	☐	☒	
NRC Safety Evaluation Report and supplements for the initial FSAR[1]	☐	☒	
NRC Safety Evaluations for amendments to the Operating License[1]	☐	☒	
If "YES", perform an Exemption Review per Section III OR perform a 50.59 Evaluation per Section IV OR obtain NRC approval prior to implementing the change. If obtaining NRC approval, document the LBD change in Section II.A.5; no further 50.59 review is required. However, the change cannot be implemented until approved by the NRC. AND initiate an LBD change in accordance with NMM ENS-LI-113.			

LBDs controlled under other regulations	YES	NO	CHANGE # (if applicable) and/or SECTIONS IMPACTED
Quality Assurance Program Manual[2]	☐	☒	
Emergency Plan[2, 3]	☐	☒	
Fire Protection Program[3, 4] (includes the Fire Hazards Analysis)	☐	☒	
Offsite Dose Calculations Manual[3, 4]	☐	☒	
If "YES", evaluate any changes in accordance with the appropriate regulation AND initiate an LBD change in accordance with NMM ENS-LI-113. No further 50.59 review is required.			

[1] If "YES," see Section 5.2[5]. No LBD change is required.
[2] If "YES," notify the responsible department and ensure a 50.54 Evaluation is performed. Attach the 50.54 Review.
[3] Changes to the Emergency Plan, Fire Protection Program, and Offsite Dose Calculation Manual must be approved by the OSRC in accordance with NMM OM-119.
[4] If "YES," evaluate the change in accordance with the requirements of the facility's Operating License Condition or under 50.59, as appropriate.

2. **Does the proposed activity involve a test or experiment not described in the FSAR?** ☐ Yes ☒ No

If "yes," perform a 50.59 Evaluation per Section IV OR obtain NRC approval prior to implementing the change AND initiate an LBD change in accordance with NMM LI-113. If obtaining NRC approval, document the change in Section II.A.5; no further 50.59 review is required. However, the change cannot be implemented until approved by the NRC.

3. **Basis**

Explain why the proposed activity does or does not impact the Operating License/Technical Specifications and/or the FSAR and why the proposed activity does or does not involve a new test or experiment not previously described in the FSAR. Discuss other LBDs if impacted. Adequate basis must be provided within the Screening such that a third-party reviewer can reach the same conclusions. Simply stating that the change does not affect TS or the FSAR is not an acceptable basis.

Licensing Basis Documents (Operating License, Technical Specifications, NRC Orders)

The Operating License was reviewed but it does not contain a detailed description of the reactor coolant system or pressurizer penetration design so there is no impact to that document.

Technical Specifications- TS 3/4.4 Reactor Coolant System was reviewed for potential impact during repair activities. TS 3.4.1.5 Cold Shutdown - Loops Not Filled is not applicable because repair activities will not affect operability or availability of two trains of shutdown cooling. Watertight plugs will be installed during repair activities to allow refueling activities to proceed in parallel with pressurizer repairs and repairs do not require RCS water level to be lowered below elevation 18 feet which is considered "reduced inventory" with loops filled.

NRC Orders- No Orders were identified which are applicable to the design of the pressurizer.

LBDs Controlled under 50.59 (FSAR, TS Bases, TRM, COLR, NRC SERs)

FSAR- Changes to the FSAR are needed to remove the references to the, plugged heater sleeve, and the removal of the mechanical clamp seals.

Revise FSAR Chapter 5 to delete the reference to the plugged Heater Sleeve F4 from Table 5.2-3, Table 5.4-6, and Figure 5.4-6. Delete discussion about Heater Sleeves C1 and C3, and MNSA-2 from Section 5.4.3.2. Change Material Specification for heater sleeves in Table 5.2-3 from SB-167 to SB-166.

Revise FSAR Chapter 8 to revise / add notes to Figure 8.3-33, Table 8.3-1, and Table 8.1-2 to account for the reinstatement of Heater F4.

TS Bases/ TRM- As described above, no changes to the TS are required as a result of the proposed repairs to the pressurizer or heater element upgrade. Likewise, no TS Bases changes, TRM, or COLR changes are necessary.

LBDs controlled under other regulations (QAPM, Emergency Plan, Fire Protection Program, Offsite Dose Calculations Manual)

The QAPM, EP, FP Program and ODCM were considered but none of these programs or documents described the design of the pressurizer and none were impacted by the repairs proposed by ER-W3-2004-0122-000.

Tests or Experiments Conclusions- The change being evaluated is the physical repair of the pressurizer heater sleeves and instrument nozzles with superior materials that are less susceptible to PWSCC. The replacement of the existing heater elements with a more reliable design is also authorized. No unusual tests or experiments are required other than routine installation and acceptance testing.

4. References

Discuss the methodology for performing LBD searches. State the location of relevant licensing document information and explain the scope of the review such as electronic search criteria used (e.g., key words) or the general extent of manual searches per Section 5.5.1[5](d) of LI-101. **NOTE: Ensure that manual searches are performed using controlled copies of the documents. If you have any questions, contact your site Licensing department.**

Controlled copies of the FSAR and TS for WF3 from the on-line library were reviewed. The following documents were also reviewed:

ER-W3-2004-0122-002, RF-13 Repair of Pressurizer Heater Sleeves and Instrument Nozzles, ER-W3-1999-0184-00; ER-W3-1999-0184-02; ER-W3-1999-0184-07; ER-W3-2001-1211-00
Design Specification DES-III-022, Rev. 1, Pressurizer Heaters
SI Drawings 04152, R0, 04139, R0 – Sheets 1 and 2
Additional references:
ASME BP&V Codes, Sections III, XI, II and IX
CE Owners Group - CEOG Task 637 "Corrosion and Erosion Testing of Pressurizer Shell Material Exposed to Borated Water
CE Report No. 99-TR-FSW-006 Rev. 0 "Waterford 3 Pressurizer Half-Nozzle Repair Carbon Steel Corrosion Evaluation"
Procedure FP-001-016 "Hot Work", Procedure UNT-007-059 "FME"
CR 99-0204, CR-W3-2004-4035
EPRI NP-3784, A survey of literature on low-alloy steel fastener corrosion in PWR power plants
Drawing 1564-1186 showing pressurizer surge line with screen

LBDs/Documents reviewed via keyword search:	Keywords:
LRS: 50.59 Search	"pressurizer heater sleeve", "pressurizer heater element", "Alloy 600", "Alloy 690"

LBDs/Documents reviewed manually:

Technical Specifications 3.1.1. 3.3.2, 3.3.3.5, 3.3.3.6, 3.4.3, 3.4.5.2, 3.4.7, 3.4.9
FSAR Sections 3.1.29, 5.2.3, 5.4.3.2, 5.4.10, 6.2, 7.6.1.9, 9.3, 9.5, 15.6
FSAR Tables 3.5-4, 5.2-3, 5.4-6, 8.1-2, 8.3-1
FSAR Figures 5.4.6, 8.3-33

5. **Is the validity of this Review dependent on any other change?** ☒ Yes ☐ No

If "YES", list the required changes/submittals. The changes covered by this 50.59 Review cannot be implemented without approval of the other identified changes (e.g., license amendment request). Establish an appropriate notification mechanism to ensure this action is completed.

Relief Requests: W3-R&R-003; Ambient Temperature Temper Bead Welding requests an alternate ambient temperature machine GTAW temper bead technique for dissimilar metal weld repairs. W3-R&R-004; Remnant Sleeve Flaw Evaluation requests 1) the use of K_{Ic} versus K_{Ia} in ASME Section XI fracture mechanics evaluations, 2) the use of elastic plastic fracture mechanics (EPFM) in ASME evaluations, and 3) the use of worst case remnant flaw assumptions in lieu of fully characterizing cracks. ERD Actions have been assigned to document NRC approval of each relief request.

The following ASME III and ASME XI calculations are being performed by Structural Integrity Associates (SIA) in support of this modification package. A Return to Service (RTS) Action in ERD will track the approval and issue of these documents as identified in DRN 05-302:

- SIR-05-036, Rev. 0, "Design Report, Waterford Steam Electric Station Pressurizer Bottom Head Heater Sleeve Nozzle Repairs"
- SIR-05-037, Rev. 0, "Design Report, Waterford Steam Electric Station Pressurizer Bottom Head Instrument Nozzle Repairs"
- SIR-05-038, Rev. 0, "Design Report, Waterford Steam Electric Station Pressurizer Side Shell Instrument Nozzle Repair"
- SIR-05-039, Rev. 0, "Fracture Mechanics Evaluation of Potential Remnant Cracks in Waterford Pressurizer Bottom Head Heater Sleeve Nozzles"
- SIR-05-040, Rev. 0, "Fracture Mechanics Evaluation of Potential Remnant Cracks in Waterford Pressurizer Bottom Head Instrument Nozzles"
- SIR-05-041, Rev. 0, "Fracture Mechanics Evaluation of Potential Remnant Cracks in Waterford Pressurizer Side Shell Instrument Nozzle"

Westinghouse issued a Nuclear Safety Advisory Letter (NSAL-04-5) advising Entergy of potential insurge and outsurge transients on the CE pressurizers. Depending on specific plant design and operation, these transients can potentially occur during plant heatup or cooldown. These transients may not have been fully considered as part of the original design basis for the pressurizer. Therefore, if these are unevaluated transients, the original predicted fatigue usage factor of the lower vessel region, and existing flaw analyses may not be bounding. Westinghouse has stated that this condition is not an immediate safety concern, and that it is below the threshold for Part 21 notification.

Condition Report CR-WF3-2004-02734 tracks this potential insurge and outsurge transients issue and the Corrective Actions for this CR will provide the required qualification and document update.

B. ENVIRONMENTAL SCREENING

If any of the following questions is answered "yes," an Environmental Review must be performed in accordance with NMM Procedure ENS-EV-115, "Environmental Evaluations," and attached to this 50.59 Review. Consider both routine and non-routine (emergency) discharges when answering these questions.

Will the proposed Change being evaluated:

	Yes	No	
1.	☐	☒	Involve a land disturbance of previously disturbed land areas in excess of one acre (i.e., grading activities, construction of buildings, excavations, reforestation, creation or removal of ponds)?
2.	☐	☒	Involve a land disturbance of undisturbed land areas (i.e., grading activities, construction, excavations, reforestation, creating, or removing ponds)?
3.	☐	☒	Involve dredging activities in a lake, river, pond, or stream?
4.	☐	☒	Increase the amount of thermal heat being discharged to the river or lake?
5.	☐	☒	Increase the concentration or quantity of chemicals being discharged to the river, lake, or air?
6.	☐	☒	Discharge any chemicals new or different from that previously discharged?
7.	☐	☒	Change the design or operation of the intake or discharge structures?
8.	☐	☒	Modify the design or operation of the cooling tower that will change water or air flow characteristics?
9.	☐	☒	Modify the design or operation of the plant that will change the path of an existing water discharge or that will result in a new water discharge?
10.	☐	☒	Modify existing stationary fuel burning equipment (i.e., diesel fuel oil, butane, gasoline, propane, and kerosene)?[1]
11.	☐	☒	Involve the installation of stationary fuel burning equipment or use of portable fuel burning equipment (i.e., diesel fuel oil, butane, gasoline, propane, and kerosene)?[1]
12.	☐	☒	Involve the installation or use of equipment that will result in a new or additional air emission discharge?
13.	☐	☒	Involve the installation or modification of a stationary or mobile tank?
14.	☐	☒	Involve the use or storage of oils or chemicals that could be directly released into the environment?
15.	☐	☒	Involve burial or placement of any solid wastes in the site area that may affect runoff, surface water, or groundwater?

[1] See NMM Procedure ENS-EV-117, "Air Emissions Management Program," for guidance in answering this question.

C. SECURITY PLAN SCREENING

If any of the following questions is answered "yes," a Security Plan Review must be performed by the Security Department to determine actual impact to the Plan and the need for a change to the Plan.

Could the proposed activity being evaluated:

	Yes	No	
1.	☐	☒	Add, delete, modify, or otherwise affect Security department responsibilities (e.g., including fire brigade, fire watch, and confined space rescue operations)?
2.	☐	☒	Result in a breach to any security barrier(s) (e.g., HVAC ductwork, fences, doors, walls, ceilings, floors, penetrations, and ballistic barriers)?
3.	☐	☒	Cause materials or equipment to be placed or installed within the Security Isolation Zone?
4.	☐	☒	Affect (block, move, or alter) security lighting by adding or deleting lights, structures, buildings, or temporary facilities?
5.	☐	☒	Modify or otherwise affect the intrusion detection systems (e.g., E-fields, microwave, fiber optics)?
6.	☐	☒	Modify or otherwise affect the operation or field of view of the security cameras?
7.	☐	☒	Modify or otherwise affect (block, move, or alter) installed access control equipment, intrusion detection equipment, or other security equipment?
8.	☐	☒	Modify or otherwise affect primary or secondary power supplies to access control equipment, intrusion detection equipment, other security equipment, or to the Central Alarm Station or the Secondary Alarm Station?
9.	☐	☒	Modify or otherwise affect the facility's security-related signage or land vehicle barriers, including access roadways?
10.	☐	☒	Modify or otherwise affect the facility's telephone or security radio systems?

Documentation for accepting any "yes" statement for these reviews will be attached to this 50.59 Review or referenced below.

D. INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) SCREENING

(NOTE: This section is not applicable to Waterford 3 and may be removed from 50.59 Reviews performed for Waterford 3 proposed activities.)

If any of the following questions is answered "yes," an ISFSI Review must be performed in accordance with NMM Procedure ENS-LI-112, "72.48 Review," and attached to this Review.

Will the proposed Change being evaluated:

	Yes	No	
1.	☐	☒	Any activity that directly impacts spent fuel cask storage or loading operations?
2.	☐	☒	Involve the Independent Spent Fuel Storage Installation (ISFSI) including the concrete pad, security fence, and lighting?
3.	☐	☒	Involve a change to the on-site transport equipment or path from the Fuel Building to the ISFSI?
4.	☐	☒	Involve a change to the design or operation of the Fuel Building fuel bridge including setpoints and limit switches?
5.	☐	☒	Involve a change to the Fuel Building or Control Room(s) radiation monitoring?
6.	☐	☒	Involve a change to the Fuel Building pools including pool levels, cask pool gates, cooling water sources, and water chemistry?
7.	☐	☒	Involve a change to the Fuel Building handling equipment (e.g., bridges and cask cranes, structures, load paths, lighting, auxiliary services, etc)?
8.	☐	☒	Involve a change to the Fuel Building electrical power?
9.	☐	☒	Involve a change to the Fuel Building ventilation?
10.	☐	☒	Involve a change to the ISFSI security?
11.	☐	☒	Involve a change to off-site radiological release projections from non-ISFSI sources?
12.	☐	☒	Involve a change to spent fuel characteristics?
13.	☐	☒	Redefine/change heavy load pathways?
14.	☐	☒	Fire and explosion protection near or in the on-site transport paths or near the ISFSI?
15.	☐	☒	Involve a change to the loading bay or supporting components?
16.	☐	☒	New structures near the ISFSI?
17.	☐	☒	Modifications to any plant systems that support dry fuel storage activities?
18.	☐	☒	Involve a change to the nitrogen supply, service air, demineralized water or borated water system in the Fuel Building?

IV. 50.59 EVALUATION

License Amendment Determination

Does the proposed Change being evaluated represent a change to a method of evaluation ONLY? If "Yes," Questions 1 – 7 are not applicable; answer only Question 8. If "No," answer all questions below. ☐ Yes ☒ No

Does the proposed Change:

1. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the FSAR? ☐ Yes ☒ No

   BASIS:

   The accidents previously evaluated that are applicable to this change are described in Chapters 6 and 15 of the FSAR. These accidents are the Loss Of Coolant Accident (LOCA) and the Inadvertent Operation of the Emergency Core Cooling System (ECCS). Although the failure of a pressurizer heater sleeve is not specifically discussed, the frequency of occurrence of the LOCA could potentially be increased if the integrity of the RCS pressure boundary is degraded as a result of modification implementation. The Inadvertent Operation of the ECCS could be potentially affected because pressurizer instrumentation provides input to the Safety Injection Actuation Signal (SIAS) and Containment Isolation Actuation Signal (CIAS) functions of the Engineered Safety Features Actuation System (ESFAS).

   The design of the repairs proposed for the pressurizer heater sleeves and instrument nozzles comply with all applicable ASME Section III, Class 1 requirements, except where relief is requested as described in the response to Part II.A Question 5. The fabrication and installation of the nozzle repairs is in accordance with ASME Section XI requirements, consistent with Waterford 3 ASME Section XI program per 10CFR50.55a. The partial penetration J-groove welds and fillet welds will be controlled by vendor welding procedures that will be reviewed and approved by qualified Waterford 3 personnel. Non-destructive examination will be performed to verify acceptability of the welds in accordance with ASME requirements. The new nozzles/sleeves will be machined as a one-piece design (machined from either Alloy 690 forgings or bar stock). The replacement heater elements which are being supplied in accordance with Design Specification DES-III-022 meet or exceed all applicable ASME Code requirements. The welding of new sleeves or nozzles to the pressurizer will be performed by either Waterford 3 or qualified vendor personnel in accordance with applicable requirements of ASME Section XI. The installation of the one-piece designed heater sleeve at the pressurizer mid-wall (ASME 533 Gr. B, Class1) will require a bimetallic weld using ambient temperature temper bead welding in accordance with ASME Code Case N-638-0. Deposition of weld metal pads on the exterior of the pressurizer will also require ambient temperature temper bead welding in accordance with ASME Code Case N-638-0. A finite element analyses will be prepared to demonstrate that the repair designs comply with the applicable ASME Code requirements. These analyses, which follow the rules of ASME Section III Sub-Article NB-3200, reflect that all calculated primary and membrane stresses in the critical weld sections meet the ASME Code Allowable stress values (ref. Structural Integrity Calculations SIR-05-036, SIR-05-037, SIR-05-038).

   In addition, there are no design changes to any instrumentation lines associated with this modification. All original analyzed configurations are maintained. The proper operation of all affected instrument loops will be verified by post modification testing prior to the unit being returned to service.
   In summary, the proposed changes associated with implementation of pressurizer heater and instrument nozzle repairs meet all design and licensing basis requirements and therefore the

pressurizer vessel integrity and the RCS pressure boundary integrity are maintained consistent with original design. The frequency of occurrence of the accidents described above or any other accident that is described in FSAR Chapter 15 is not increased. Additional design considerations related to this change are discussed below

Fracture Mechanics / Crack Propagation:

A portion of the original Alloy 600 heater sleeve or nozzle and the original J-groove weld attachment and cladding will remain in place where stress corrosion cracking could initiate or propagate. An evaluation was performed which demonstrated that PWSCC cracking would arrest at the low alloy steel and crack propagation by fatigue would be acceptable for the remaining life of the plant (including life extension) and not challenge the pressurizer structural integrity (ref. Structural Integrity Calculations SIR-05-039, SIR-05-040, SIR-05-041).

Corrosion

The repair design allows for thermal expansion of the remnant sleeve or nozzle welded to the inside of the pressurizer and the new sleeve or nozzle welded to the outside or mid-wall of the pressurizer. In all cases a small gap is created where the low alloy steel of the pressurizer will be exposed to the RCS boric acid environment. A corrosion analysis has determined that potential corrosion would be minimal and acceptable as follows:

Carbon steel/boric acid corrosion mechanisms typically involve evaporation of a relatively dilute and non-corrosive boric acid solution into a concentrated and corrosive acid with a pH of less than 3. However, RCS pH is maintained by procedure between 4.5 and 11 (ref. CE-002-006), where the corrosion rate is substantially reduced. In addition, the lower limit of the contained water volume, the specified boron concentration, and the physical size (approximately 600,000 gallons) of the WSP also ensure a pH value of between 7.0 and 11.0 for the solution recirculated within containment after a LOCA. Concentrated boric acid can cause high general dissolution corrosion (wastage) of localized regions of hot carbon steel surfaces. The corrosion rate for this form of corrosion is most severe in the temperature range of 350°F to 400°F and it diminishes on either side of this band. The normal operating temperature for the RCS is well above 400°F and normal shutdown temperature is less than 150°F. Therefore, because the duration of RCS heat-up and cool-down in the corrosive band is very short, significant corrosion will not occur. In the unlikely event that the pressurizer temperature was maintained for a period of time in the undesirable temperature ranges of 350°F to 400°F, accelerated corrosion would not occur because the oxygen levels would be low, the pH is well above 3, and the wetting and drying conditions would not exist.

Also, the conditions required to concentrate boric acid to a corrosive pH level are not present in the locations of the pressurizer where the low alloy steel is exposed. Specifically, it is under conditions of wetting and drying that boric acid will concentrate and eventually form a saturated solution. Saturated boric acid at 200 degrees F has a pH of less than 3 (Ref. EPRI NP-3784, a survey of literature on low-alloy steel fastener corrosion in PWR power plants). Boric acid concentration in the vessel penetration areas will be limited below saturation because there is no wetting and drying process at those locations. During infrequent refueling outages when the pressurizer sleeves/nozzles may be allowed to dry, the temperatures are well below the 350°F to 400°F range when corrosion is most significant. Further CE has submitted an evaluation (Report 99-TR-FSW-006, Carbon Steel Corrosion Evaluation, Revision 0 including calculation ECM94-011) concluding that the estimated lifetime of a half-nozzle repair was over 450 years. The evaluation consisted of a review of industry experience and laboratory testing, including an assessment of potential galvanic corrosion.

Stress Corrosion Cracking:

The pressurizer material is SA-533, Grade B, Class 1, which is considered to be a low alloy steel (LAS) (carbon steel with small per cent of Mo and Ni). The yield strength of SA-533, Grade B, Class 1 is approximately 50 Ksi, which is far below levels typical of SCC attacked materials

referenced in the EPRI NP-3784. The pressurizer LAS material has high fracture toughness and an inherently high resistance to PWSCC. Therefore, stress corrosion cracking which initiates in Alloy 600 components would self-arrest if it propagated and reaches the low alloy steel of the pressurizer. The only mechanism available for further crack propagation in the low alloy steel material is fatigue. . Therefore, stress corrosion cracking of the pressurizer material exposed to primary water will not occur.

Hydrogen Embrittlement:

The susceptibility of a material to hydrogen embrittlement generally depends on the strength level of the steel, and resistance to embrittlement decreases with increasing strength (Metals Handbook). In addition, hydrogen embrittlement decreases with increasing temperature. The pressurizer shell is fabricated from SA-533, Grade B material with a yield strength of approximately 50 ksi. Although this material has a high toughness it is not considered a high strength steel. In addition, the internal stainless steel cladding of the shell, while providing a barrier to boric acid, provides no barrier to hydrogen migration into the base metal. Hydrogen can permeate throughout the cladding and saturate the base metal. This modification has no effect on the susceptibility of the base metal to hydrogen embrittlement because the base metal has always been exposed to hydrogen through the stainless steel cladding.

2. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component important to safety previously evaluated in the FSAR? ☐ Yes ☒ No

BASIS:

The structure, system, or component (SCC) important to safety that is related to the proposed activity is the pressurizer vessel and the RCS pressure boundary. A comprehensive discussion is provided in answering the previous question that provides the basis of why the pressurizer and RCS pressure boundary are being maintained equal to or better than the original design. There are no new system interactions or connections, and there are no new failure modes associated with equipment important to safety. The pressurizer heater elements serve no safety function except that a portion of the heater forms part of the RCS pressure boundary where it is welded to the bottom end of the heater sleeve. This portion of the heater elements are designed and manufactured in accordance with ASME Section III requirements and the heaters are hydrostatically tested to ensure pressure boundary integrity. The replacement nozzles and heater sleeves as well as the weld filler materials have superior resistance to PWSCC. All applicable ASME stress allowables are satisfied for the repairs, the ASME Section XI fracture mechanics stress analysis reflects that potential crack growth are within allowable limits, and potential boric acid corrosion or metal wastage of exposed low alloy steel within the vessel wall is insignificant. Therefore, the likelihood of occurrence of a malfunction of a SCC important to safety will not be increased with the proposed changes.

3. Result in more than a minimal increase in the consequences of an accident previously evaluated in the FSAR? ☐ Yes ☒ No

BASIS:

The RCS is a fission product barrier credited with mitigating the consequences of a Loss of Coolant Accident. The pressurizer pressure instrumentation loops provide input to the RPS and also to the SIAS and CIAS functions of the ESFAS. Although top instrument nozzles A & C are being re-welded to remove Alloy 182 material, post modification testing will ensure that the function of the associated instruments are fully restored. No changes are being made to the design of the pressurizer pressure instruments or instrument loops. Upon completion of the work activities, backfilling of the instrument sensing lines and functional testing, will verify that the instrument loops attached to the nozzles are functioning properly. Therefore, the instrumentation and its interface with the RPS and ESFAS will continue to function to mitigate the consequences of accidents as currently designed. The integrity of the RCS pressure boundary will be maintained by continued conformance to all applicable ASME Code requirements and the integrity will be improved by replacing Alloy 600 pressure boundary materials with Alloy 690

materials that are more corrosion resistant to PWSCC. As a result, it can be concluded that this modification does not result in more than a minimal increase in the consequences of an accident previously evaluated in the FSAR.

4. Result in more than a minimal increase in the consequences of a malfunction of a structure, system, or component important to safety previously evaluated in the FSAR? ☐ Yes ☒ No

BASIS:

The proposed activity does not result in more than a minimal increase in the consequences of a malfunction of a SCC important to safety previously evaluated in the FSAR because the integrity of the RCS will be either maintained or improved. The function and mitigation requirements of the RCS are not modified and no changes in the assumptions concerning equipment availability or failure modes have been made. The proposed repair activity has no impact on the pressurizer pressure instruments or instrument loops, therefore, the instrumentation and its interface with the RPS and ESFAS will continue to function to mitigate the consequences of accidents as designed.

5. Create a possibility for an accident of a different type than any previously evaluated in the FSAR? ☐ Yes ☒ No

BASIS:

The proposed repairs will not create a possibility for an accident of a different type than any previously evaluated in the FSAR because the function and integrity of the RCS has not been altered or degraded. The RCS will continue to meet all applicable design requirements so the integrity will be maintained or improved. There are no new system interactions or connections, and there are no new failure modes associated with equipment important to safety. The pressurizer heater elements serve no safety function except that a portion of the heater forms part of the RCS pressure boundary where it is welded to the bottom end of the heater sleeve. This portion of the heater elements are designed and manufactured in accordance with ASME Section III requirements and the heaters are hydrostatically tested to ensure pressure boundary integrity.

The pressurizer repairs will be implemented during a plant outage while the RCS is depressurized. To allow refueling activities to proceed in parallel with pressurizer repairs and to avoid the need to operate the RCS at reduced inventory, watertight plugs will be used to seal the instrument nozzles and heater sleeves during some repair activities. The watertight plugs will be hydrostatically tested to ensure that they can withstand a pressure greater than the Static Head Pressure exerted by 30 feet of water in the pressurizer and reactor cavity multiplied by a factor of 2 to conservatively account for potential seismic acceleration. It is also planned that secondary backup plugs will be installed in heater sleeves and instrument nozzles whenever repair activities allow, providing redundant sealing capability. Heater sleeves and instrument nozzles will be cleaned by grinding or flapping prior to plug insertion to ensure that an ideal sealing surface is provided. In the unlikely event that minor leakage occurs, and adjustment of the secondary seal is unsuccessful in eliminating the leakage, leak collection will be installed and the repair of the sleeve will be rescheduled during a drain-down window. Even in the unlikely worst case event where a plug were completely ejected, the bottom of the pressurizer is higher than the RCS loops so the ability to maintain shutdown cooling would not be affected.

6. Create a possibility for a malfunction of a structure, system, or component important to safety with a different result than any previously evaluated in the FSAR? ☐ Yes ☒ No

BASIS:

As described in the response to questions 1 through 5, the integrity and operability of the RCS pressure boundary and components will not be degraded by the proposed repairs. Also the functional capability of the instrumentation will not be affected by the proposed repairs because the internal dimensions of the instrument nozzles are not changed and proper operation will be verified by post modification testing. The replacement heaters are like the existing heaters in terms of form, fit and function. The proposed change provides a functionally equivalent design, and there are no new failure modes or system interactions created.

The potential for the remaining portion of the original nozzle/heater sleeve to fall into the pressurizer is extremely low. In order for this to occur, the cracking would have to progress or form, completely around the circumference of the existing nozzle/heater sleeve. Industry experience and stress analyses have shown that the cracks typically propagate and grow axially. Multiple axial cracks will relieve the stresses in the nozzle and arrest further cracking initiation. Therefore, substantial weld and nozzle ligament will remain and prevent the nozzle or heater sleeve stub piece from falling into the pressurizer. The modification of the original partial penetration weld sleeve/nozzle design moves the partial penetration weld joint to either the mid-wall or the outside surface of the pressurizer vessel where previously the joint was on the inside surface. The remnant sleeve/nozzle is no longer part of the RCS pressure boundary. In addition, there is a screen filter over the pressurizer surge line which will prevent a loose part from migrating into the RCS flow path, even, in the unlikely event, it did fall into the pressurizer.

The Refueling Water Level Indicating System (RWLIS) is designed to monitor the water level in the RCS and the refueling pool during refueling operations. This system is also used to monitor the water level in the RCS hot leg during maintenance operations that require the RCS to be drained down to the vicinity of the hot leg. The reference leg for this level indicating system is attached to one of the pressurizer upper head nozzles (ref. valve RC-311). During the implementation of this modification the reference leg for RWLIS will be disconnected from the pressurizer. This is acceptable because typically when RWLIS is in service during a refueling outage the pressurizer man-way is open to atmosphere, and after the reference leg is disconnected from the pressurizer, it will still see atmospheric pressure. Therefore disconnecting the reference leg from the pressurizer will not affect the operability of the RWLIS.

Therefore this modification will not increase the probability of occurrence of a malfunction of equipment important to safety of a different type than previously evaluated.

7. Result in a design basis limit for a fission product barrier as described in the FSAR being exceeded or altered? ☐ Yes ☒ No

BASIS:

The fission product barriers identified in the WF3 Licensing Bases are the fuel cladding, the Reactor Coolant System, and the Containment Building. The pressurizer is a part of the RCS pressure boundary, but the proposed activity does not alter or exceed a pressurizer/RCS design basis limit. The new heater sleeve designs are rated for the design pressure and temperature of the pressurizer (2,500 psia and 700°F); therefore, the proposed activity does not change or exceed the pressurizer design basis pressure and temperature limits as described in FSAR Table 5.4-6. Furthermore, the new pressurizer heater sleeve designs will conform to the applicable ASME Code Section III requirements for Class 1 components. Therefore, the stress design limits (Code allowables) for the pressurizer and the design basis limits for fission barriers as described in the FSAR will not be exceeded or altered.

8. Result in a departure from a method of evaluation described in the FSAR used in establishing the design bases or in the safety analyses? ☐ Yes ☒ No

BASIS:

The analyses for the new heater sleeve and instrument nozzle designs have been properly and completely reconciled with the requirements of the original construction code for the WF3 Pressurizer (ASME Section III, 1971 Edition, Summer 1971 Addenda). The new pressurizer heaters meet the appropriate requirements of the original construction code, ASME Boiler and Pressure Vessel Code, Section III, Subsection NB, 1971 Edition through Summer 1971 Addenda. As an alternative, the replacement pressurizer heaters may be supplied to a later Edition and/or Addenda of ASME Section III provided the Edition/Addenda used was endorsed by the NRC per 10CFR50.55a and the use of the later Edition/Addenda of ASME Section III is reconciled, by the supplier, in accordance with the reconciliation provisions of the 1995 Edition/1996 Addenda of ASME Section XI.

Entergy Request for Alternative W3-R&R-004, Remnant Sleeve Flaw Evaluation, will request the use of K_{1c} versus K_{1a} in ASME Section XI, IWB-3600 linear elastic fracture mechanics (LEFM) evaluations in the specific case described as follows: Entergy will evaluate the postulated remnant sleeve flaw for the pressurizer insurge/outsurge transients at low temperatures using LEFM methods. The IWB-3613 acceptance criterion for such flaws is $K_{1a}/\sqrt{2}$, where the temperature is above RT_{NDT} + 60° F and the pressure is below 20% of the design pressure. The calculated stress intensity factor for the postulated flaw size may be near the allowable flaw size when the allowable is $K_{1a}/\sqrt{2}$. Entergy will request that an allowable stress intensity factor of $K_{1c}/\sqrt{2}$ vs. $K_{1a}/\sqrt{2}$ be approved, where the temperature is above RT_{NDT} + 60° F and the pressure is below 20% of the design pressure.

Entergy also requests relief from IWB-3610 and proposes an alternative evaluation procedure based on elastic plastic fracture mechanics (EPFM) for portions of the flaw evaluation. IWB-3610 uses linear elastic fracture mechanics. Elastic-plastic fracture mechanics will be used for loading conditions that are at plant operating temperature and, therefore, in the Charpy V-Notch upper shelf regime for the low alloy steel pressurizer material.

The proposed activity is strictly a structural/mechanical design change and does not impact the pressurizer size, capacity, control systems or affect a change to a method of evaluation described in the FSAR used in establishing the design bases or in the safety analyses.

If any of the above questions is checked "YES", obtain NRC approval prior to implementing the change by initiating a change to the Operating License in accordance with NMM Procedure ENS-LI-113.