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Joseph E. Venable
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Waterford 3

W3F1-2002-0032

April 1, 2002

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Waterford Steam Electric Station, Unit 3
Docket No. 50-382
15 Day Response to NRC Bulletin 2002-01, Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity

REFERENCES:
1. Entergy Letter Dated September 4, 2001, "30 Day Response To NRC Bulletin 2001-01 For Waterford 3; Circumferential Cracking of VHP Nozzles" (W3F1-2001-0081)
2. Entergy Letter Dated November 8, 2001, "Supplement to 30 Day Response To NRC Bulletin 2001-01 For Waterford 3; Circumferential Cracking of VHP Nozzles" (W3F1-2001-0104)

Dear Sir or Madam:

By letter dated March 18, 2002 the NRC issued Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," requiring licensees to provide a 15-day response. Attached is the Entergy Operations, Inc. (Entergy) response for the Waterford Steam Electric Station, Unit 3 (Waterford 3).

Entergy recognizes the safety significance of the events discussed in the Bulletin and is committed to a timely and complete resolution of the issue. At this time, Entergy believes there is reasonable assurance that regulatory requirements are currently being met and will continue to be met. Entergy will continue to monitor industry experience regarding this Bulletin for applicability to Waterford 3.

The bare metal effective visual examination of the Waterford 3 vessel head penetrations is currently underway and is approximately 80% complete. No evidence of boric acid deposits or nozzle leakage has been identified.

This letter is submitted pursuant to 10 CFR 50.54(f) and contains information responding to NRC Bulletin 2002-01, for Waterford 3. Commitments made in this letter are identified in Attachment 2.

If you have any questions or require additional information, please contact D. Bryan Miller at 504-739-6692.

I declare under penalty of perjury that the foregoing is true and correct. Executed on April 1, 2002.

Sincerely,

J. E. Venable
Vice President, Operations
Waterford Steam Electric Station, Unit 3

JEV/DBM/cbh

Attachments:
1. 15 Day Response to NRC Bulletin 2002-01
2. List of Regulatory Commitments

cc: E.W. Merschoff, NRC Region IV
N. Kalyanam, NRC-NRR
J. Smith
N.S. Reynolds
NRC Resident Inspectors Office
Louisiana DEQ/Surveillance Division
American Nuclear Insurers

Attachment 1

W3F1-2002-0032

15 Day Response to NRC Bulletin 2002-01,
Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity

15 Day Response to NRC Bulletin 2002-01, Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity

1. Within 15 days of the date of this bulletin, all PWR addressees are required to provide the following:

A. a summary of the reactor pressure vessel head inspection and maintenance programs that have been implemented at your plant,

Response

Inspections of the Reactor Pressure Vessel (RPV) head are performed every cycle in accordance with Generic Letter (GL) 88-05[1]. The inspection, conducted by engineers, looks for any signs of leakage on the RPV head (e.g., dripping, rust stains on insulation, steam leaks, boric acid crystals, etc.) and is conducted while the RCS system is hot without removing the insulation. The RPV head flange area around the studs is also inspected for evidence of boric acid coming from sources on the head. In the event boric acid is identified, its source is determined and appropriate actions taken.

Inservice inspection personnel also routinely perform inspections of the accessible portions of the head including the head-to-head flange weld. Also, other personnel perform activities such as reactor vessel disassembly and control element drive mechanism maintenance around and above the head each outage. During these activities the RPV head ventilation ductwork is disassembled, providing access for visual inspection of the top surface of the reactor head insulation through eighteen 16" x 28" openings in the support skirt. These openings are located immediately above the head flange and provide excellent accessibility for viewing the reactor head dome area for evidence of boric acid on or coming from under the insulation.

An inspection of the RPV head, with insulation installed, was performed during RF10 (October 2000) as part of the Generic Letter 88-05 boric acid walkdown program. Additionally, during RF10, ISI personnel inspected the circumferential head-to-head flange weld. These inspections and the other activities described above did not reveal any evidence of boric acid leakage or accumulation that would impact RPV head integrity.

In RF8 (April 1997) a bare metal inspection of approximately 30 percent of the RPV head was performed around the perimeter of the head. This inspection included approximately 20 percent of the vessel head penetrations. No evidence of corrosion or nozzle leakage was identified during this inspection.

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[1] Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants," March 17, 1988

B. an evaluation of the ability of your inspection and maintenance programs to identify degradation of the reactor pressure vessel head including, thinning, pitting, or other forms of degradation such as the degradation of the reactor pressure vessel head observed at Davis-Besse,

Response

Previously it was not possible to perform a 100% bare metal inspection of the Waterford 3 RPV head without expending significant resources to modify the permanently installed reflective insulation. Due to the significance of this issue Waterford 3 has taken a proactive position and is modifying the insulation during the current refueling outage to facilitate the effective bare metal inspection committed to in Entergy's response for Waterford 3 to Bulletin 2001-01[2].

On the Combustion Engineering head, all welds on the nozzle and control element drive mechanism (CEDM) components except for the J-weld on the inner diameter of the head are located above the insulation. If any leaks were to occur on any of these welds boric acid crystals would be visible from above. As stated above, GL 88-05 inspections and other routine maintenance activities are performed every cycle that would identify such leakage. No leakage or accumulation of boric acid crystals has been identified at Waterford 3 that has or would lead to the wastage as identified at Davis-Besse. The following discussion provides the bases for this conclusion.

Per NUREG/CR-6245[3], leakage over a significant amount of time (six to nine years) and significant amounts of boric acid (~12 cubic feet of crystals) would be required to corrode the RPV head to a point where it challenges the structural integrity of the head. Per CEN-607[4], CEN-614[5], and NUREG/CR-6245, it is highly unlikely that the evidence of this leakage would go undetected over a six to nine year period (i.e., approximately four to six GL 88-05 inspections). Twelve cubic feet of boric acid crystals is equivalent to ~1000 pounds of boric acid. If corrosion is approximately proportional to leakage, then several tenths of a gpm over several years would be required to challenge the structural integrity of the head.

Material Reliability Program (MRP) personnel at Davis-Besse, participating in the root cause evaluation, recently briefed the PWR fleet on the head wastage condition at Davis-Besse. During this briefing it was revealed that significant amounts of boric acid crystals had been evident on the RPV head, in the area of

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[2] NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles."
[3] NUREG/CR-6245, "Assessment of Pressurized Water Reactor Control Rod Drive Mechanism Nozzle Cracking," October 1994
[4] CEN-607, "Safety Evaluation of the Potential for and Consequences of Reactor Vessel Head Penetration Alloy 600 ID-Initiated Nozzle Cracking," May 1993
[5] CEN-614, "Safety Evaluation of the Potential for and Consequences of Reactor Vessel Head Penetration Alloy 600 OD-Initiated Nozzle Cracking," December 1993

the wastage, for several years prior to the discovery of the wastage. It was also noted that evidence of this leakage was visible near the flange of the RPV head (boric acid had run down the slope of the head to the flange area.) The conditions at Davis-Besse, as described above, are consistent with the conditions that are known to cause such wastage as described in NUREG/CR-6245 (i.e., large amounts of boric acid crystals over six to nine years and evidence of continuous leakage.) The information presented in the initial Davis-Besse Probable Cause Summary Report supports this assessment.

Additionally, CEOG document CE NPSD-690-P[6] has previously evaluated inspecting the small bore Inconel 600 nozzles that could leak due to Primary Water Stress Corrosion Cracking (PWSCC) without removing the insulation. The document reports that if 10 pounds of boron crystals were to buildup due to PWSCC leakage, the boron would either extrude from the annulus region between the insulation and nozzle or from the ends of the insulation. Although this evaluation was prepared for the small bore penetrations, it is considered to be applicable to the RPV head at Waterford 3 because of the numerous joints between the nozzles and fiberglass donuts and between the donuts and the reflective insulation.

Based on the results of the GL 88-05 inspections, along with other routine inspections of the RPV head, per response 1.A above, it is reasonable to believe that no RPV head degradation has occurred at Waterford 3. As stated previously, Entergy will be conducting a 100% bare metal, effective visual examination of the Waterford 3 RPV head during the current refueling outage.

C. **a description of any conditions identified (chemical deposits, head degradation) through the inspection and maintenance programs described in 1.A that could have led to degradation and the corrective actions taken to address such conditions,**

Response

During RF4 (December 1989), boron was observed under the movable in-core drain line and on the northwest side of the RPV head. Corrective actions were taken to eliminate the leak from the moveable incore instrument nozzle. The areas exposed to the boric acid were inspected and cleaned. Approximately 20 pounds of boric acid crystals were removed from the surface of the insulation. Four sections of insulation along the perimeter of the head in the northwest quadrant were removed to facilitate inspections of the head. Following reinstallation of the insulation, localized accumulations of dry boric acid were observed on the exterior and bottom of the stainless steel insulation panels in the NW, N, and E quadrants. Additional inspections under the insulation were performed by shining a light under the insulation in the SW and NE quadrants of the head. No RPV head corrosion was identified during the RF4 inspections.

[6] CE NPSD-690-P, "Evaluation of Pressurizer Penetrations and Evaluation of Corrosion after Unidentified Leakage Develops," January 1992.

During RF5 (October 1992) minor leakage was noted past the outer o-ring on the RPV flange. The leak was repaired. An inspection around the area of the leak noted corrosion on RPV flange stud numbers 7, 8 and 9. The corrosion consisted of general degradation of approximately 1/32 inches deep with an occasional pit 1/16" inches deep. The largest area of corrosion was noted on Stud #9, which had an affected area about 6 in. long and 8 in. circumference. The studs were cleaned and examined by magnetic particle testing. The studs were evaluated by engineering as acceptable based on review of the RPV stress report. No RPV head corrosion was observed.

During RF8 (April 1997) portions of the reflective insulation were lifted around the perimeter of the RPV head (~30%) to facilitate inspection under the insulation where the boron deposits had been removed during RF4 and to inspect approximately 20% of the Vessel Head Penetration (VHP) nozzles for signs of PWSCC. The majority of the area inspected was smooth and free of deposits however thin layers of dry boric acid crystals scattered in various patches were noted. These patches of dry boric acid crystals were cleaned from the RPV head and the area reexamined. The bare surface of the head examined was found to be in good condition with no evidence of corrosion.

Additionally, over the years, minor control element drive mechanism pressure housing vent leakage (or leakage from startup venting) has been noted by indications of boric acid crystals on the control element drive mechanism coil stacks well above the head. This leakage has not reached the external surface of the insulation on the head.

D. **your schedule, plans, and basis for future inspections of the reactor pressure vessel head and penetration nozzles. This should include the inspection method(s), scope, frequency, qualification requirements, and acceptance criteria, and**

Response

Waterford 3 is currently shut down for RF11. In response to Bulletin 2001-01, Entergy has committed to perform an effective visual examination of essentially 100% of the outer bare metal surface of the vessel head penetrations for evidence of leakage. If evidence of leakage is found, additional examinations of the penetration will be performed to characterize the nature and extent of cracking and disposition as required by IWA-5250 of the ASME Section XI Code. Additionally, an evaluation will be performed to determine if there is the potential for wastage of the RPV head material adjacent to the identified leak. As recommended by Bulletin 2001-01, an effective visual examination is the appropriate inspection method for Waterford 3, based on its design and effective time-at-temperature.

The 100% effective visual examination being performed during RF11 is being implemented in a fashion that provides a video record documenting the as-

found conditions and the as-left conditions following a general cleaning, if required, of the RPV head to remove any residual boric acid deposits. The results of the RF11 vessel head penetration inspections will be provided to the NRC staff in accordance with Bulletins 2001-01 and 2002-01[7] within 30 days after plant startup.

Decisions on future RPV head inspections, beyond RF11, will be made based on industry experience (e.g., results of ongoing inspections, root cause determination of Davis-Besse event, MRP and NRC recommendations, etc.)

E. **your conclusion regarding whether there is reasonable assurance that regulatory requirements are currently being met (see the Applicable Regulatory Requirements, above). This discussion should also explain your basis for concluding that the inspections discussed in response to Item 1.D will provide reasonable assurance that these regulatory requirements will continue to be met. Include the following specific information in this discussion:**

(1) If your evaluation does not support the conclusion that there is reasonable assurance that regulatory requirements are being met, discuss your plans for plant shutdown and inspection.

(2) If your evaluation supports the conclusion that there is reasonable assurance that regulatory requirements are being met, provide your basis for concluding that all regulatory requirements discussed in the Applicable Regulatory Requirements section will continue to be met until the inspections are performed.

Response

As discussed in Entergy's Bulletin 2001-01 response for Waterford 3, all regulatory requirements are being met based on the current inspections being conducted. The bare metal inspection being performed during the current refueling outage further assures all regulatory requirements will be met. The bases for this statement are as follows. For significant material wastage (including sub-surface cavities) to occur, current industry information indicates a through-wall leak and/or leakage from above the RPV head must occur. Additionally, significant boric acid concentrations must exist on the head and the areas remain wetted over extended periods (i.e., years) to accomplish significant wastage. Based on information known to date, as a minimum, there would have to be a through-wall leak and a sustained wetted surface to cause RPV head wastage similar to that found at Davis-Besse. Industry experience indicates that through-wall leakage will be visible on the surface of the head allowing detection via a bare metal visual examination as will be performed during the current refueling outage at Waterford 3. A review of the RPV stress

[7] NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," March 18, 2002

report indicates that adequate safety margin exists for the RPV head thickness, stresses and fatigue usage factor to facilitate some surface wastage (~3") without impacting the structural integrity of the head. Thus sufficient time exists to identify and repair nozzle leaks prior to the occurrence of structurally significant wastage as found at Davis-Besse.

Waterford 3 is currently shut down for RF11 and is performing an effective visual examination of the RPV head in accordance with the commitment made in response to Bulletin 2001-01. As stated above, if evidence of leakage is found, additional examinations of the penetration will be performed to characterize the nature and extent of cracking and disposition as required by IWA-5250 of the ASME Section XI Code. Following these activities a general cleaning, if required, will be performed on the head to remove boric acid deposits. In the event that wastage is identified, appropriate corrective actions will be taken in accordance with the Entergy Appendix B corrective action process. These activities, in combination, provide additional assurance that the integrity of the Waterford 3 RPV head is maintained and therefore the regulatory requirements are being met.

Attachment 2

W3F1-2002-0032

List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Entergy in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
Additionally, an evaluation will be performed to determine if there is the potential for wastage of the RPV head material adjacent to the identified leak.	X		Prior to Startup from RF11
The 100% effective visual examination being performed during RF11 is being implemented in a fashion that provides a video record documenting the as-found conditions and the as-left conditions following a general cleaning, if required, of the RPV head to remove any residual boric acid deposits.	X		Prior to Startup from RF11
The results of the RF11 vessel head penetration inspections will be provided to the NRC staff in accordance with Bulletins 2001-01 and 2002-01 within 30 days after plant startup.	X		within 30 days after plant startup