Omaha Public Power District
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LIC-15-0069
May 13, 2015

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Fort Calhoun Station, Unit No. 1
Renewed Facility Operating License No. DPR-40
NRC Docket No. 50-285

Subject: Omaha Public Power District (OPPD) Response to NRC Request for Additional Information Regarding Relief Request RR-14

References:
1. Letter from OPPD (L. P. Cortopassi) to NRC (Document Control Desk), "Relief Request Number RR-14, Request for Relief from Paragraph -3142.1(c) of ASME Code Case N-729-1 for Reactor Vessel Head Penetration Nozzle Welds," dated May 9, 2015 (LIC-15-0066)
2. E-mail from NRC (C. F. Lyon) to OPPD (B. R. Hansher), "Fort Calhoun Station, Unit No.1- Request for Additional Information for Fort Calhoun Relief Request RR-14, Reactor Vessel Head Inspections," dated May 11, 2015
3. E-mail from NRC (C. F. Lyon) to OPPD (B. R. Hansher), "RAIs for RR-14 (TAC No. MF6206)," dated May 12, 2015

In Reference 2, the NRC requested additional information regarding Relief Request RR-14 submitted by OPPD in Reference 1. In Reference 3, the NRC modified the Reference 2 request by removing Question 13(e) from consideration.

Accordingly, OPPD's response to Reference 2 is attached.

Please note that OPPD is making a regulatory commitment to conduct an inspection of the reactor vessel head nozzles under the insulation should the plant enter Mode 4 (i.e., Cold Shutdown) in excess of 72 hours during Cycle 28.

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If you should have any questions regarding this submittal or require additional information, please contact Mr. Bill R. Hansher at 402-533-6894.

Respectfully,

Louis P. Cortopassi
Site Vice President and CNO

LPC/KGM/mle

Attachments
1. OPPD Response to NRC Request for Additional Information Regarding Relief Request RR-14
2. Reactor Vessel Head Nozzle Photographs
3. Response to Request for Additional Information Question #6 Regarding Fort Calhoun Relief Request RR-14

c: M. L. Dapas, NRC Regional Administrator, Region IV
C. F. Lyon, NRC Senior Project Manager
S. M. Schneider, NRC Senior Resident Inspector

# OPPD Response to NRC Request for Additional Information Regarding Relief Request RR-14

REQUEST FOR ADDITIONAL INFORMATION
RELIEF REQUEST NUMBER RR-14
ALTERNATIVE INSPECTION OF REACTOR VESSEL
CLOSURE HEAD WITH RESPECT TO ASME
CODE CASE N-729-1 AS CONDITIONED BY 10CFR50.55A
OMAHA PUBLIC POWER DISTRICT
DOCKET NUMBER 50-285

By letter dated May 9, 2015 Omaha Public Power District (the licensee) requested authorization of a proposed alternative from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, associated with the examination requirements of Code Case N-729-1 at Fort Calhoun Station (FCS). The licensee proposed an alternative examination requirement for the reactor vessel head nozzles as documented in Relief Request Number RR-14. To complete its review, the Nuclear Regulatory Commission (NRC) staff requests the following additional information.

**NRC Question:**

1. **(a) Identify all reactor vessel head penetration nozzles (with designated nozzle numbers) where corrosion, boric acid deposits, discoloration and other evidence of nozzle leakage (as defined in 3141(c) of Code Case N-729-1) were present at the nozzle annulus region. (b) Of all the nozzles, identify the nozzles that have been considered with a relevant condition.**

OPPD Response:

(a) See Response 1(a) for each nozzle in Attachment 2.

(b) See Response 1(b) for each Nozzle in Attachment 2. Note that Nozzles labeled "Relevant" are those where the as found condition was considered relevant from the start. Nozzles initially evaluated as "Not Relevant" and later changed to "Relevant" are noted as such in Attachment 2.

**NRC Question:**

2. **If a relevant condition is considered at a nozzle, describe the evaluation and the basis for determination that the corrosion, boric acid deposits, or discoloration present was not indicative of nozzle leakage. In your discussion provide the following:**

   **(a) Provide photographic evidence of these relevant conditions.**

   **(b) Discuss the visual evidence obtained that showed the relevant conditions in each nozzle annulus that came from above of the reactor vessel closure head.**

**(c) Discuss the chemical analysis performed on each relevant condition. Including in the discussion, describe (a) where each chemical swipe was taken in relation to each reactor vessel head nozzle annulus, (b) the evidence showing conclusively that no boric acid was contained in the chemical swipe, and (c) the testing performed to show that the chemical swipe could not have come from nozzle leakage.**

OPPD Response:

(a) See Attachment 2 for photographs.

(b) See Attachment 2 for photographs showing conditions in the nozzle annulus demonstrating deposits from above the reactor closure head. Relevance was not determined considering indications of boron alone. Based on the level of boron and the pH boric acid is a low contributor of deposit.

(c) Additional analysis for identification of Tolyltriazole, a key compound of the CCW additive, CorrShield NT4204, was completed on samples with sufficient quantity to conduct this analysis. These samples did identify Tolyltriazole in them, indicating that CCW was a key contributor to the deposit. Further confirmation of the source of the boron can be found in the isotopic ratio of Co-58/60. The Co-58/60 ratio in the RCS liquid during this operating cycle was approximately 10. The isotopic ratios of the samples with enough volume to count were in the range of 0.1 to 0.3, typical of the general contamination found in containment and provide additional confirmation that there is no evidence of fresh RCS leakage. The sum of the sample evidence shows that the predominate plant species in the deposits originate in the CCW.

**NRC Question:**

3. **If the corrosion, boric acid deposits, or discoloration identified was not considered a relevant condition, (a) describe the basis for that determination, including whether the material present was removed by vacuuming and the results of chemical analysis of such debris. (b) If observations and chemical test data are not available for the nozzle under consideration, describe the basis by which it was determined that the material present in the annulus could not have come from nozzle leakage.**

OPPD Response:

See Attachment 2. The attachment describes the basis for determining relevant conditions for the penetrations.

**NRC Question:**

4. **Discuss any nozzles that had relevant conditions indicative of possible nozzle leakage but were not evaluated per the requirements of paragraph -3142.1(b)(1) of ASME Code Case N-729-1. If yes, provide justification the nozzle was not evaluated. As part of response to Questions 1 through 4, provide a table that contains the information of the relevant conditions and dispositions of each nozzle to clarify the status of the nozzle conditions.**

OPPD Response:

See Attachment 2. The attachment documents the nozzles that had relevant conditions and basis of the evaluation using the requirements of the code concluding deposits from above the head.

**NRC Question:**

5. **Discuss previous inservice inspections performed. (a) Discuss whether previous inspections (including boric acid control walkdowns, previous visual examination (VE) inspection, etc.) found boric acid on the reactor vessel head or found reactor vessel head nozzles with masked indications. If so, which nozzles identified as having relevant indications in the current VE inspection have had previous boric acid indications at the nozzle annulus region? (b) Provide the month and year of the inspections.**

OPPD Response:

(a) The previous Code Case N-729 bare metal inspection was performed on April 20, 2011 (WO369095-01, CR 2011-3423). This remote inspection was conducted within the required every third refueling outage inspection interval after the RVH replacement in the fall of 2006. Minor boric acid was reported present at penetrations with the exception of CEDM penetrations 04, 05, 21, 25, and 28 and ICI penetrations 43, 44, 45, and 46. Boric acid deposits were attributed to a maintenance induced reactor coolant system (RCS) spill on April 15, 2011 (CR 2011-3065). This approximate 5 gallon spill of refueling boron concentration water flowed down to the RVH through the head insulation. The report concludes that the lack of any visible corrosion products in the boric acid deposits also was in line with the deposits resulting from the recent leakage. The deposits found on the RV nozzle annuli were in the bottom half of the annuli which gave further evidence to support that the spillage came from on top of the RVH. No pressure boundary leakage on the RVH was therefore reported.

(b) The last bare metal inspection was conducted on April 20, 2011 (WO369095-01, CR 2011-3423).

**NRC Question:**

6. **Page 3 of the relief request states, "...There is no evidence of a flaw in any of the RVH [reactor vessel head] nozzles or partial penetration welds; therefore, performing emergent supplemental examination and/or repair/replacement of the nozzles does not result in a compensating increase in the level of quality or safety..." The NRC staff questions that there is no evidence of relevant conditions indicative of possible nozzle leakage because the NRC questions the effectiveness of the licensee's disposition of the relevant conditions. As such, the NRC staff is concerned regarding the potential for nozzle ejection or significant degradation of the low alloy steel reactor vessel head due to boric acid corrosion if the nozzles with relevant conditions are allowed to remain in service. Therefore, provide technical basis to demonstrate that nozzle ejection or a loss of upper head structural integrity will not occur during the duration of this proposed alternative. If the licensee has performed calculations to address the level of quality or safety for the proposed alternative, the NRC staff notes that the time to leakage, given the short operational lifetime of the current**

**reactor vessel head would not provide a sufficient basis for crack growth rate improvement factors due to the use of alloy 690 or its weld materials.**

OPPD Response:

Concern for Nozzle Ejection

See Attachment 3 which concludes even without crediting any time for crack initiation and throughwall penetration and even without crediting the improved performance of Alloys 690/52/152 versus Alloys 600/82/182, nozzle ejection is shown to be precluded during the duration of the proposed alternative.

Concern for Boric Acid Corrosion of Low-Alloy Steel

See Attachment 3 which concludes even without crediting the improved performance of Alloys 690/52/152 versus Alloys 600/82/182, a loss of upper head structural integrity is shown to be precluded during the duration of the proposed alternative.

**NRC Question:**

7. **Page 3 of the relief request identifies several nozzles associated with the FCS Control Element Assembly rack extensions. Are any of these nozzles the ones with relevant conditions indicative of possible nozzle leakage?**

OPPD Response:

The nozzles in question are control element drive mechanisms (CEDM) 14, 15, 16, 17, 30, 31, 32, 33, 34, 35, 36, and 37, which are dual rack extensions. CEDMs 14, 15, 16, and 17 are nozzles with relevant conditions.

**NRC Question:**

8. **Page 3 of the relief request notes that there is no qualified ultrasonic examination technique for the FCS ICI nozzles because of its thickness. (a) Are any of these nozzles the ones with relevant conditions indicative of possible nozzle leakage? (b) Provide justification why performing an ultrasonic examination of the ICI nozzles is a hardship, given that the licensee should have been aware, prior to this inspection, that an ultrasonic inspection of the FCS ICI nozzles may be required.**

OPPD Response:

a) The six ICI nozzles are conservatively considered nozzles with relevant conditions because inspections were performed post cleaning. These nozzles do not show any conditions indicative of possible nozzle leakage.
b) Currently, EPRI does not have a mock up for ICI's with a 1" wall thickness. It is estimated for the completion of the design, manufacturing, and vendor qualification on a mock up would require a lead time of approximately nine to twelve months. Therefore, an emergent inspection of any ICI would require performance by manual surface examination. Manual surface examinations require significantly more time for an individual to be under the Reactor Vessel Head increasing dose and inspection time. The hardship is the additional dose required for alternative examinations on an

expedited basis to determine possible nozzle leakage when inspections performed post cleaning have determined that there has been no occurrence of nozzle leakage.

**NRC Question:**

9. **Page 3 of the relief request notes a hardship that performance of supplemental examinations would cause a radiological dose of two REM. (a) Is this dose for a supplemental examination of the entire head, including the necessary manual examinations due to the licensee not having a qualified ultrasonic inspection technique? (b) What is the actual radiological dose associated with performing the paragraph -3200(b) supplemental examinations of ASME Code Case N-729 on the penetration nozzles and associated welds with relevant conditions indicative of nozzle leakage?**

OPPD Response:

(a) The dose estimate is for the supplemental examination of the entire head. The dose rates are approximately 200-250 mRem/hr. Volumetric UT examinations would be done by automation and it is estimated one Rem for the whole head. Manual PT would be done on penetrations that do not have qualified ultrasonic inspection technique (ICI) and that is estimated to be 15 min/penetration under the head, 30 min/penetration outside the head for a total of 0.9 to 1.125 Rem. Eddy current testing of the 6 ICI nozzles is estimated to take 10 minutes/penetration under the head for a dose of 0.2 to 0.25 Rem. It is estimated that this job would take 10 days to complete if pursued on a 24 hours basis. Additional dose was included to cover moving the head to get equipment installed, to modify the reactor vessel head stand as needed to perform the inspection and supplemental personnel/oversight.

(b) Actual radiological doses are not available since the inspection has not been performed. Assuming that the inspection consisted only of the nozzles that were deemed not relevant by our VT-2 qualified personnel, the dose would be approximately one Rem for the inspection alone.

**NRC Question:**

10. **Page 4 of the relief request identifies performance of an enhanced leakage monitoring and action plan to identify leakage promptly. (a) Address how the leakage limits will identify leakage from the penetration nozzle and/or associated J-groove welds given the low operational history of leakage rates from 0.001 to 0.1 gpm. (b) What actions will be taken at these leakage limits? (c) Are there airborne radiation monitoring equipment in the area of the upper reactor vessel head? (d) Due to the high corrosion rates associated with boric acid on low alloy steel, provide a unidentified leakage limit that is lower than the leakage limit in the current plant Technical Specifications for the inspection of the reactor vessel head nozzles, or justify why a lower limit for unidentified leakage is not needed.**

OPPD Response:

The FCS Technical Specification required tests and ER-AP-331-1003 are our current guidance and criteria that the Plant will continue to follow. It sets the FCS Technical Specification limits per section 2.1.4 at no pressure boundary leakage, 1 gpm unidentified leakage, 10 gpm identified leakage, and 150 gallons per day primary to secondary leakage

through any one Steam Generator. This sets the FCS test limits per OP-ST-RC-3001 and ER-AP-331-1003 at much lower levels.

a) These leakage limits by themselves cannot physically identify the difference between a leak at a nozzle penetration or weld versus a leak at any other location in the CVCS or RCS system, especially given the low operational levels of past cycles. However, a great deal of analysis and inspection can be applied at these limits to positively identify the likelihood of a leak on the RVH and the necessity of performing an inspection of the RVH nozzles. Analysis can be quickly applied to known points of possible leakage within the monitored systems to quickly eliminate possible locations and identify the possibility of an RVH leak. During normal and the low action level; monitored parameters in addition to the leak rate include:
   - Containment Sump level and temperature
   - Spent Regenerent Tank Levels
   - Aux Building Sump level
   - Aux Building Room 21/22/23 Sump levels
   - Volume Control Tank level
   - Pressurizer Quench Tank level and temperature
   - Reactor Coolant Drain Tank level
   - Safety injection Tank Levels (for back leakage through check valves)
   - Pressurizer pressure / level (for test fluctuations)
   - RCS temperature (for test fluctuations)
   - Primary-to-Secondary Leak Rate Chemistry
   - Radiation Monitors
   - CEDM seal temperatures
   - Charging Pump Packing leakage (on demand)

   At higher Action levels there are inspections and sampling that is required to eliminate or identify possible locations. These are stated below. These action levels contain both definite, unmoving leakage levels, and levels that change each quarter based on the established baseline leakage level. All are lower than Technical Specification limits. In this way conservatism is maintained for both a lower than nominal or higher than nominal baseline from previous cycles.

b) The RCS Unknown Leakage action levels and their required actions are as follows:

- Action Level 1 at a single 7 day rolling average for the RCS unknown leak rate which exceeds 0.1 gpm, or 9 consecutive daily values greater than the baseline. This is typically the most commonly entered Action level, and is often entered into based on higher standard deviations in testing for a given period, or sudden degradations in equipment that cause a high leak rate before repairs can be enacted, such as Charging pump packing failure or valve leak by. Required actions are to document the event in a CR, confirm the indications and check for equipment manipulations that may render the data invalid, then evaluate the trends of monitored parameters and look for abnormal trends to correct. Repairs and corrections are to be made as appropriate when the leakage is identified.

- Action Level 2 at either 2 consecutive daily values of unidentified RCS leakage greater than 0.15 gpm, or 2 of 3 consecutive daily unidentified RCS leak rate values greater than the baseline plus two standard deviation values. This is the second most likely action level to be entered, although it is not common to do so. It is most often entered due to an equipment failure that can occur quickly but take a day or so to identified, such as valve leak by that requires thermal scans to find. It can sometimes be entered into due to high leakage values resulting from Plant transients such as down powers or equipment tests. Required actions are to perform a confirmatory leak test and if confirmed then perform all Action Level 1 required actions. Additional required actions are to notify PHC of the event and to provide updates, maintain an event timeline to ensure proper documentation of the event, and initiate a leak investigation to determine if the leakage is inside or outside Containment. The source and location of the increased leakage is to be identified from evaluation of Plant parameters and evolution history. If evidence suggests the leakage is inside Containment, visual inspections of accessible locations is required. Samples of various drains and other locations are to be taken for analysis. If the leakage cannot be located but evidence still supports a location inside Containment; then remote inspections of inaccessible locations and placement of local filters to obtain airborne radiation data is to be recommended. Repairs and corrections are to be made as appropriate when the leakage is identified.

- Action Level 3 at 1 daily RCS unidentified leakage value greater than 0.3 gpm, or greater than the baseline plus 3 standard deviation values. This action level is almost never entered due to its high statistical significance. It was not entered during Cycle 27. All Action Level 1 and 2 actions are required, as well as more frequent samples. If data suggests the increased leakage is inside Containment, the placement of air filters to check local airborne radiation levels and remote inspections of inaccessible locations is no longer recommended; it is required. If remote inspections still do not identify leakage, a down power is to be scheduled to allow for detailed examinations of inaccessible locations (ex: the RVH) as reviewed and recommended by PORC or the Plant Manager.

c) There is no airborne radiation monitoring equipment in the vicinity of the RVH; inlets to these process monitors are located further towards the outer edge of Containment.

d) As stated above; Action Level 3 (1 daily RCS unidentified leakage value greater than 0.3 gpm, or greater than the baseline plus 3 standard deviation values) is the level at which remote inspections and detailed inspections of the RVH will be required if the source of the leakage cannot be identified elsewhere.

**NRC Question:**

**11. On page 4 and 5, the chemical analysis performed identified "minor concentrations of boron." (a) How much boric acid residue is considered as a relevant condition? (b) How did the chemical analysis show conclusively that this boron was a result of "minor contamination from leakage from the RC-100 packing and ICI Port Number 44 mechanical connection"?**

OPPD Response:

(a) Samples were taken around the base of the penetration and by removing deposits around selected areas. Testing analyzed for the presence of boron, pH, tolyltriazole and radionuclide isotopic analyses for Co-58/60 ratio. The chemical analyses were directed at the identification of the presence of boron. Boric acid, used for reactivity control in the RCS, and the CCW corrosion inhibitor additive, CorrShield NT4204, both contain boron. The boric acid in the RCS contains elemental boron while the CCW additive contains boron as borate, which is not as soluble as elemental boron. The analysis performed at FCS for boron cannot differentiate between boron and borate. Both show up as boron but the historically known CCW deposits have shown boron at concentrations up to approximately 200 ppm while known boric acid samples have been analyzed at 900 ppm and above. The pH of the sample can serve to differentiate between the two compounds of boron as boric acid samples are typically less than a pH of 6. All analyzed samples had pH's that were >9, indicative of the high pH present with the Tolyltriazole and borate compounds in the CCW system.

(b) Additional analysis for identification of Tolyltriazole, a key compound of the CCW additive, CorrShield NT4204, was completed on samples with sufficient quantity to conduct this analysis. These samples did identify Tolyltriazole in them, indicating that CCW was a key contributor to the deposit. Further confirmation of the source of the boron can be found in the isotopic ratio of Co-58/60. The Co-58/60 ratio in the RCS liquid during this operating cycle was approximately 10. The isotopic ratios of the samples with enough volume to count were in the range of 0.1 to 0.3, typical of the general contamination found in containment and provide additional confirmation that there is no evidence of fresh RCS leakage. The sum of the sample evidence shows that the predominate plant species in the deposits originate from CCW.

**NRC Question:**

**12. Page 5 of the relief request identifies the non-destructive examinations performed on the reactor vessel head penetration nozzles and associated welds prior to commercial service. (a) Was the surface examination of the J-groove welds performed prior to or after the hydrostatic test during the construction? (b) How many fabrication defects were found during the ultrasonic inspection of the reactor vessel head penetration nozzles and identify whether any of those nozzles with relevant conditions indicative of possible nozzle leakage have had fabrication defects?**

OPPD Response:

a) The surface examinations conducted by Mitsubishi Heavy Industries (MHI) were performed during the welding process in late spring 2005 (April, May, and June) prior to the hydrostatic test, which was performed in October 2005. The surface examinations performed as part of the Pre-Service Inspection by Wesdyne were performed in November of 2005 after the hydrostatic test.

b) The pre-service ultrasonic inspection performed by Wesdyne (after hydrostatic test) found zero recordable indications on the reactor vessel head penetrations.

The post weld ultrasonic inspection performed by MHI in July of 2005 (before the hydrostatic test) documented the following indications:

| Nozzle No. | # of Indications | Disposition |
|---|---|---|
| 7 | 1 | Acceptable |
| 17 | 1 | Acceptable |
| 21 | 2 | Acceptable |
| 22 | 1 | Acceptable |
| 23 | 1 | Acceptable |
| 24 | 2 | Acceptable |
| 31 | 1 | Acceptable |
| 34 | 1 | Acceptable |
| 35 | 1 | Acceptable |
| 36 | 2 | Acceptable |
| 39 | 1 | Acceptable |
| 41 | 2 | Acceptable |
| 42 | 3 | Unacceptable |
| 43 | 3 | Acceptable |
| 45 | 3 | Acceptable |
| 46 | 1 | Acceptable |

The unacceptable UT indication on Nozzle #42 was dispositioned as "Use-As-Is." MHI documented that the cause of the unacceptable indication as oxide inclusion as other possible causes such as hot cracking, lack of fusion, or porosity were ruled out. MHI evaluated that the unacceptable UT indication can be evaluated as a small group of indications but if it is conservatively considered to be one large flaw and relevant for PSI/ISI activities, the flaw is still acceptable under ASME Code Section XI acceptance standards. This includes extrapolating 40 years of operation where fatigue growth of the flaw would have to be taken into consideration.

Taking into consideration the volume of weld repair required, concerns on additional heat input, the risks associated with carrying out repairs near the J-groove buttering and worldwide leakage experiences that have been associated with weld repairs on welds, the disposition of the UT indication was to Use-As-Is. This is documented in MHI Nonconformance Report UGNR-OFN-RVH-016.

**NRC Question:**

**13. Given the inspection results of Alloy 690 components identified by the licensee on page 5 of the relief request, (a) discuss the Fort Calhoun recommended change in bare metal visual inspection frequency for future reactor vessel head inspections. (b) Discuss procedures and process for the future bare metal visual inspections of the reactor vessel head nozzles. (c) Discuss evaluation methods of relevant conditions in the future bare metal visual inspection of reactor vessel head nozzles. (d) Discuss whether a volumetric examination or a bare metal visual examination of the reactor vessel head nozzles will be performed at the next refueling outage. If not, provide justification. (e) Discuss a plan regarding how to communicate to the NRC for the future inspections of the reactor vessel head nozzles to minimize the occurrence of emergent issues.**

OPPD Response:

Fort Calhoun shall perform a bare metal visual inspection in the next refueling cycle FCR28. FCS is currently scheduled to perform a volumetric exam in the next refueling outage. The inspections will be performed in accordance with the Code. A cause analysis will be performed to develop corrective actions as a result of the FCR27 inspection. Corrective actions will be implemented to ensure compliance with all code requirements.

(a) Per ASME Code Case N-729-1 -3142.1(b)(2) "...The boric acid crystals and residue shall be removed to the extent necessary to allow adequate examinations and evaluation of degradation, and a subsequent VE of the previously obscured surfaces shall be performed, prior to return to service, and again in the subsequent refueling outage..."

(b) OPPD will follow ASME Code Case N-729-1 -3141 "(a) The VE required by -2500 and performed in accordance with IWA-2200 and the additional requirements of this Case shall be evaluated by comparing the examination results with the acceptance standards specified in -3142.1. (b) Acceptance of components for continued service shall be in accordance with -3142. (c) Relevant conditions for the purposes of the VE shall include areas of corrosion, boric acid deposits, discoloration, and other evidence of nozzle leakage."

(c) OPPD will follow ASME Code Case N-729-1 3142.1 "(a) A component whose VE confirms the absence of relevant conditions shall be acceptable for continued service. (b) A component whose VE detects a relevant condition shall be unacceptable for continued service until the requirements of -3142.1(b)(1), (b)(2), and (c) below are met. (1) Components with relevant conditions require further evaluation. This evaluation shall include determination of the source of the leakage and correction of the source of leakage in accordance with -3142.3. (2) All relevant conditions shall be evaluated to determine the extent, if any, of degradation. The boric acid crystals and residue shall be removed to the extent necessary to allow adequate examinations and evaluations of degradation, and a subsequent refueling outage. Any degradation detected shall be evaluated to determine if any corrosion has impacted the structural integrity of the component. Corrosion that has reduced component wall thickness below design limits shall be resolved through repair/replacement activity in accordance with IWA-4000. (c) A nozzle whose VE indicates relevant conditions indicative of possible nozzle leakage shall be unacceptable for continued service unless it meets the requirements of -3142.2 or -3142.3."

(d) OPPD will follow ASME Code Case N-729-1 Table 1:
- Head with nozzles and partial-penetration welds of PWSCC-resistant materials
  i. Visual – Every third refueling outage or 5 calendar years, whichever is less.
- Nozzles with partial-penetration welds of PWSC-resistant materials in head
  i. Volumetric/Surface – All nozzles, not to exceed one inspection interval (nominally 10 calendar years).

(e) During a follow-up phone call with NRC Staff on May 12, 2015, this question was removed from consideration.

**NRC Question:**

**14. The operating experience has shown that corrosion rates associated with boric acid on low ally steel are aggressive. The NRC staff suggests that the licensee proposes an opportunistic inspection of the reactor vessel head nozzles under the insulation (as access permits) if the plant is required to shut down in mid-cycle. If not, justify why it is not necessary for an opportunistically inspection during the mid-cycle.**

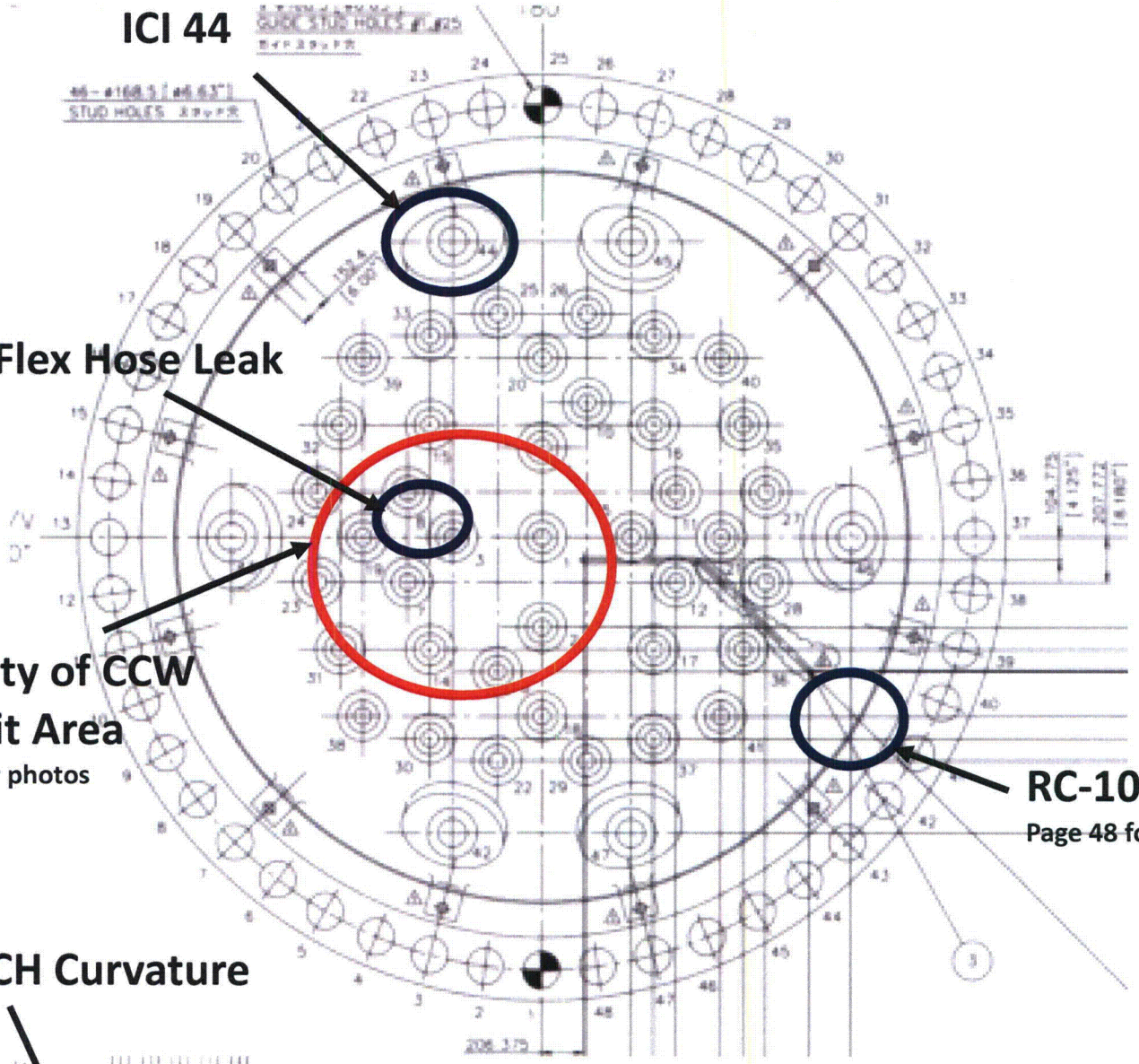
OPPD Response:

As shown in the table below, OPPD is making a regulatory commitment to conduct an inspection of the reactor vessel head nozzles under the insulation should the plant enter Mode 4 (i.e., Cold Shutdown) in excess of 72 hours during Cycle 28. Industrial and radiological safety concerns preclude such an inspection at Mode 3 (i.e., Hot Shutdown) or above.

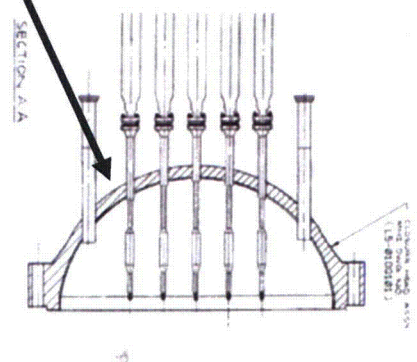
**Regulatory Commitment Table**

| Commitment | Committed Date or Outage | Commitment Type | |
|---|---|---|---|
| | | One-Time Action (Yes/No) | Programmatic (Yes/No) |
| OPPD will conduct an inspection of the reactor vessel head nozzles under the insulation should the plant enter Mode 4 (i.e., Cold Shutdown) in excess of 72 hours during Cycle 28. (**AR 63850**) | During Cycle 28 | Yes | No |

# Reactor Vessel Head Nozzle Photographs

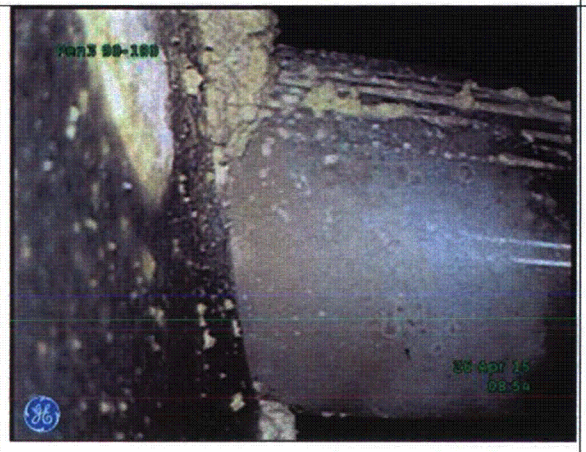
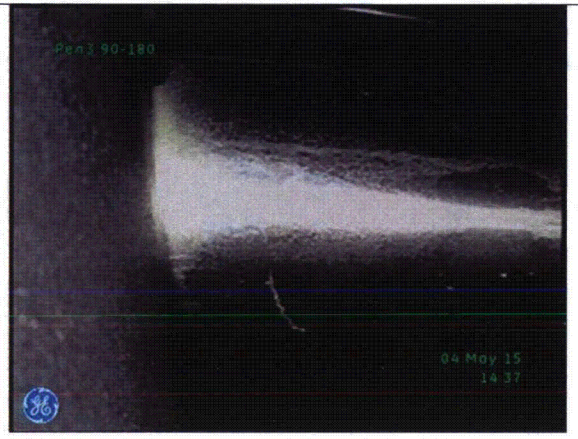


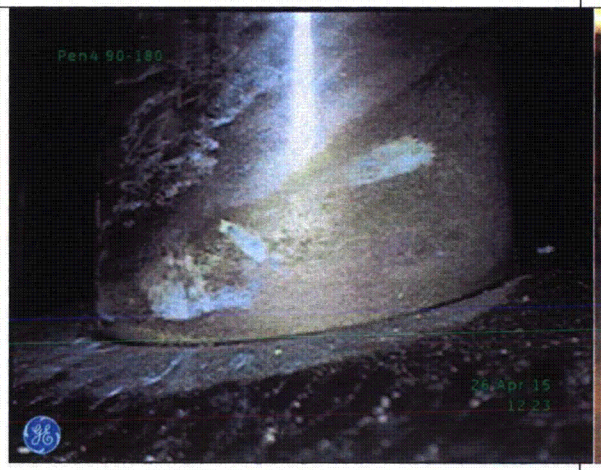

RVCH Curvature

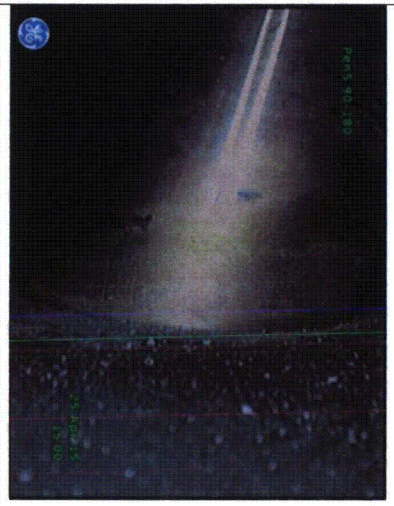


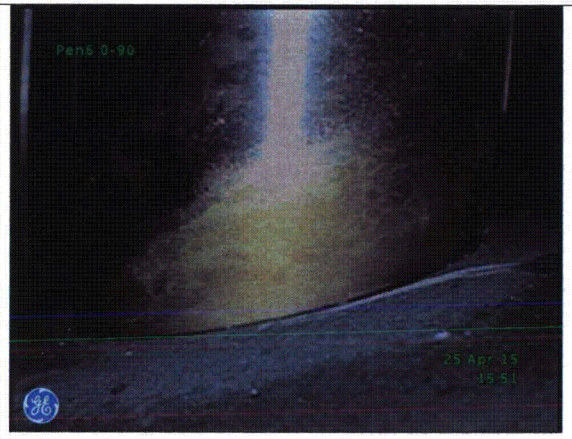
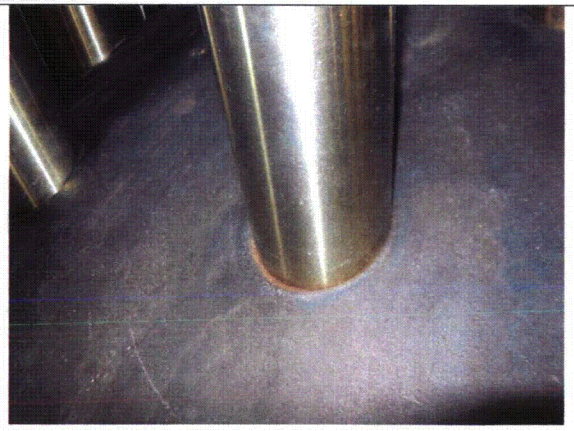
| CEDM Nozzle 1 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Buildup of discolored deposits around and on nozzle<br>(b) Relevant<br>**Question 2**<br>(b) Deposits show flow conditions from above with visible leakage indications from insulation. Deposits have yellowish tint to them. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. See plan view of page one of Attachment 2. Post vacuuming VE showed no sign of degradation/nozzle leakage.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 2 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Buildup of discolored deposits around and on nozzle<br>(b) Relevant<br>**Question 2**<br>(b) Deposits show flow conditions from above with visible leakage indications from insulation. Deposits have yellowish tint to them. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. See plan view of page one of Attachment 2. Post vacuuming VE showed no sign of degradation/nozzle leakage.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

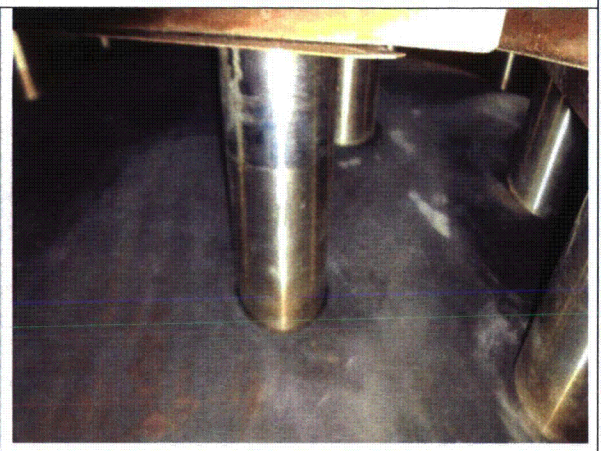
| CEDM Nozzle 3 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Buildup of discolored deposits around and on nozzle<br>(b) Relevant<br>**Question 2**<br>(b) Deposits show flow conditions from above with visible leakage indications from insulation. Deposits have yellowish tint to them. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. See plan view of page one of Attachment 2. Post vacuuming VE showed no sign of degradation/nozzle leakage.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 4 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Boric Acid dust accumulation around annulus and discoloration on Nozzle<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The photos from the initial bare metal inspection on all four sides show a small amount of light BA dust residue collected around the penetration annulus, more concentrated in the downslope side in the of the penetration nozzle. There is light discoloration of the nozzle itself on the 90-180 view, but neither the residue or discoloration are indicative of leak sources, nor are the large deposits or other visible deficiencies. The granule paths in the dust show that drifting has occurred downslope on the RVH, as one would expect from blown dust on a sloped surface.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

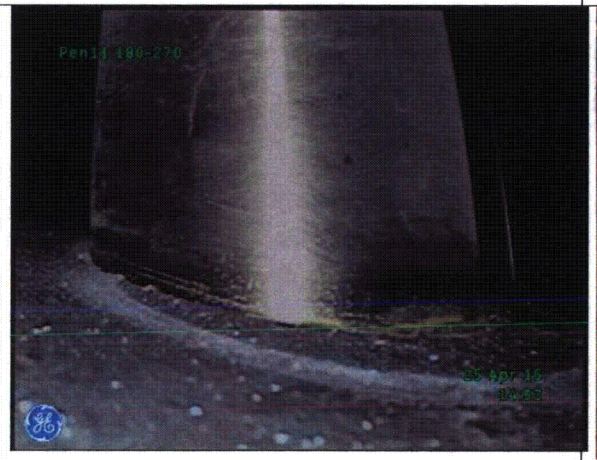
| CEDM Nozzle 5 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Light Boric Acid dust accumulation around annulus<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The photos from the initial bare metal inspection on all four sides show a small amount of light dust residue collected around the penetration annulus, more concentrated in the downslope side in the protective leeward side of the penetration nozzle. There is light discoloration of the nozzle itself on the 90-180 view. The granule paths in the dust show that drifting has occurred downslope on the RVH, as one would expect from blown dust on a sloped surface.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

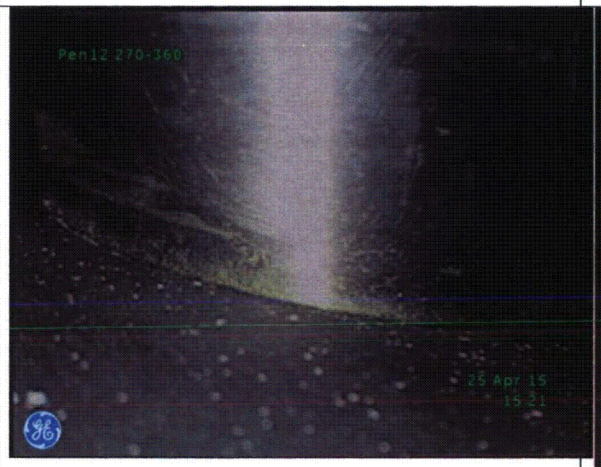
| CEDM Nozzle 6 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Little to no residue accumulation. Slight discoloration around nozzle.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>Photos from the 0-90 and 90-180 views of the initial bare metal inspection show little-to-no residue or dust collected around the penetration annulus. The nozzle itself is clean, albeit lightly discolored on the bottom and with a large glare from the camera flash. The annulus itself appears slightly lighter than surrounding bare metal, but no accumulation or BA crystals are present.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

| CEDM Nozzle 7 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Buildup of discolored deposits around and on nozzle<br>(b) Relevant<br>**Question 2**<br>(b) Deposits show flow conditions from above with visible leakage indications from insulation. Deposits have yellowish tint to them. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. See plan view of page one of Attachment 2.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

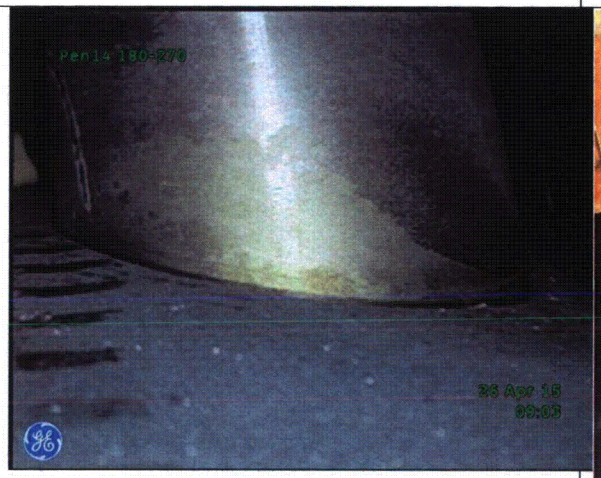
| CEDM Nozzle 8 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Buildup of discolored deposits around and on nozzle<br>(b) Relevant<br>**Question 2**<br>(b) Deposits show flow conditions from above with visible leakage indications from insulation. Deposits have yellowish tint to them. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. See plan view of page one of Attachment 2.<br>(c) See chemistry description at end of report.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 10 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a)Small amount of dust accumulation<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue. The 0-90 and 90-180 views show no accumulation of any residue on the upslope portion and sides of the penetration; the darker bare metal of the RVH is clearly apparent. A small amount of dust residue is shown accumulated in the downslope side penetration. What may be a light discoloration of the very bottom of the penetration nozzle can be seen in the photos.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

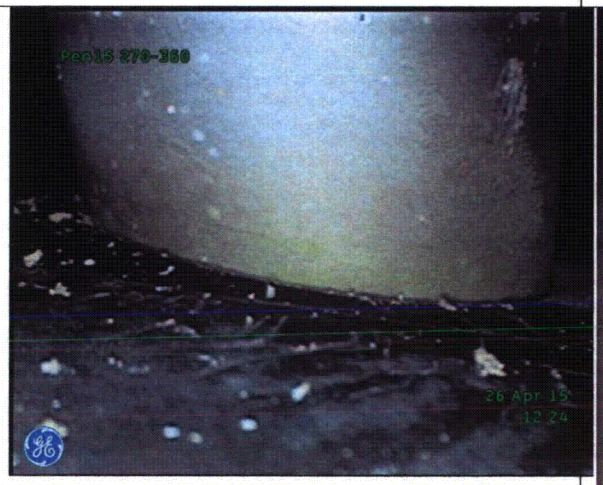
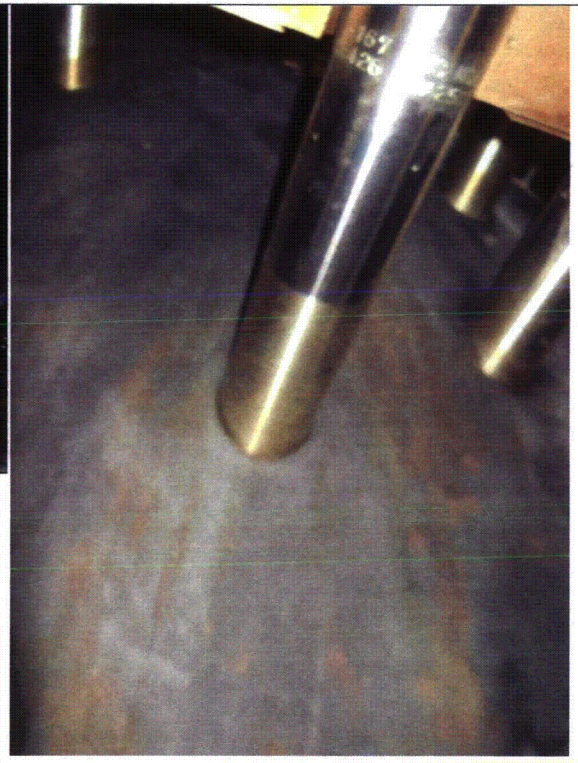
| CEDM Nozzle 11 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection on all four sides show a small amount of light dust residue collected around the penetration annulus. This is shown well in the 180-270 view, where a clear oval shaped deposit has settled on the downslope side of the nozzle. The residue is clearly a dust or a stain settled in the leeward side of a protective block from air currents, much like residue particles settled in the annulus region itself as shown in the 270-360 view on the upslope and downslope side where they could not be blown away. Neither the deposit ring or the light staining on the 270° side of the penetration nozzle are indicative of a leak source. The particles and the dust in the annulus also do not provide enough cover to potentially mask any other flaw.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

| CEDM Nozzle 12 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection on all four sides show a small amount of light BA dust residue collected around the penetration annulus, more concentrated in the downslope side in the protective leeward side of the penetration nozzle. There is light discoloration of the nozzle itself on the 270-360 view, but neither the residue or discoloration are indicative of leak sources, nor are the large deposits or other visible deficiencies. The granule paths in the dust show that drifting has occurred downslope on the RVH, as one would expect from blown dust on a sloped surface.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

Ref. WO 551120-01 and GE Detailed RVI Report
RC-6: Clean Boric Acid and Inspect Reactor Vessel Closure Head

| CEDM Nozzle 14 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection show a light dust residue on all four sides of the penetration nozzle. The residue is clearly very light and has settled there from circulation within the shroud, as evidenced by the robot crawler tracks in the 180-270 view that wipe away the residue to show the darker RVH metal beneath. There are no deposits or tracks of leakage; and only a very light droplet staining on the 270-360 view of the nozzle. The residue and staining cannot be hiding a leak source or deficiency, as the dust is so light it would show any indications underneath.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

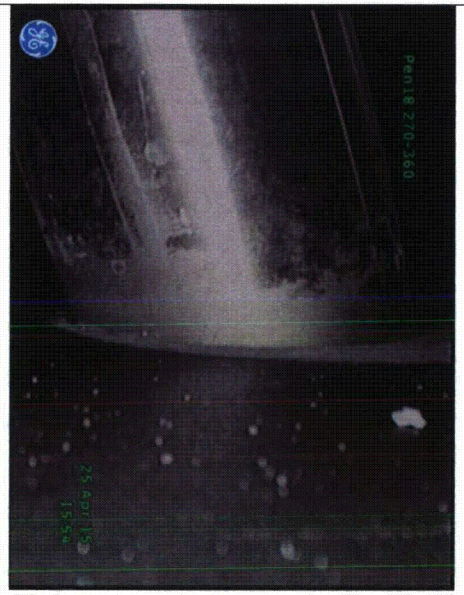
Ref. WO 551120-01 and GE Detailed RVI Report
RC-6: Clean Boric Acid and Inspect Reactor Vessel Closure Head

| CEDM Nozzle 15 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos show no dust residue on the upslope side of the penetration, although dust has settled in the annulus itself and drifted downslope in the leeward side of the penetration. The residue is the same light dust which appears at other penetrations, and no deposits or staining tracks are present. A few small granules of residue appear in the 270-360 view to the side of the penetration nozzle. All have clearly settled or drifted there from circulation within the shroud or drifting down the head; there is no presence of leaks above them like in other areas.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

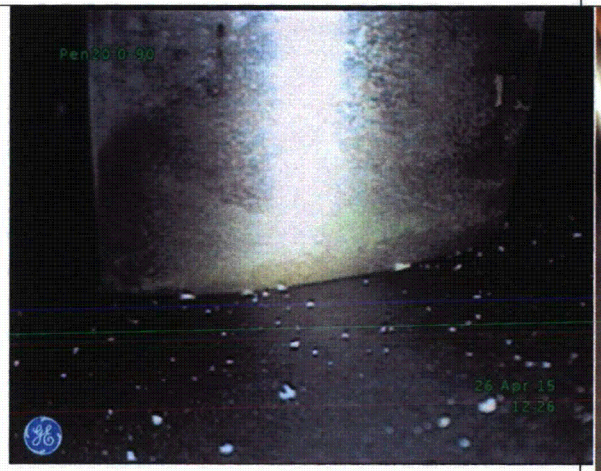
| CEDM Nozzle 16 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos show what is either a light dust of residue or light staining in the 180-270 view. It is not thick enough to mask any deficiencies or damage. Like many of the other penetrations; there are no actual material deposits, just a general dusting of light residue that has circulated within the RVH shroud and collected in a relatively protected area. This is shown well in the 270-360 view, where the darker color of the bare RVH shows through the dust.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

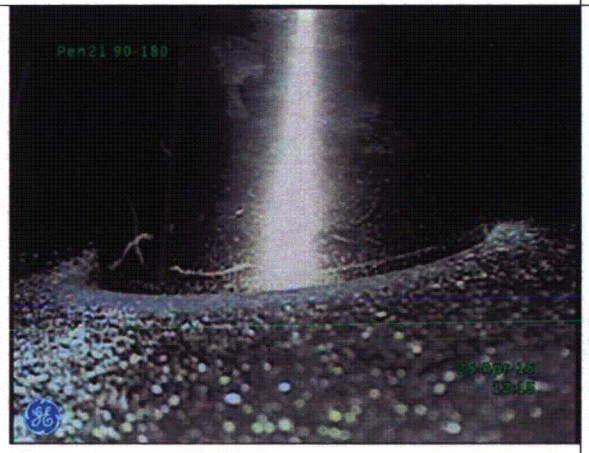
| CEDM Nozzle 17 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue, nor are the penetration located in an area immediately adjacent to one which does. Only a light dust is shown collected directly in the annulus region. There is some light staining and discoloration of the penetration nozzle itself, although some of that is due to the camera lighting. A few small granules are shown near the annulus. None of these are indicative of damage and none can mask any deficiency.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

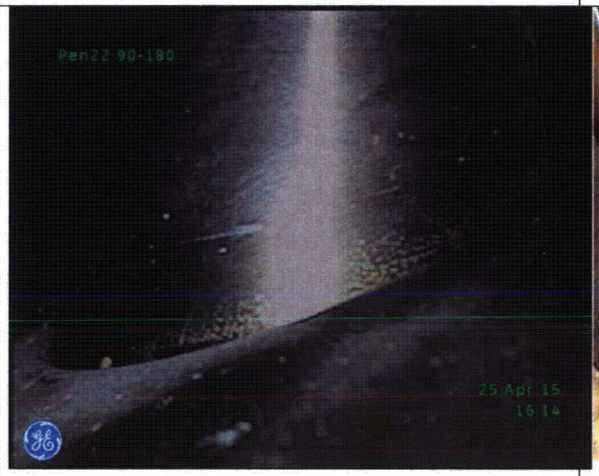
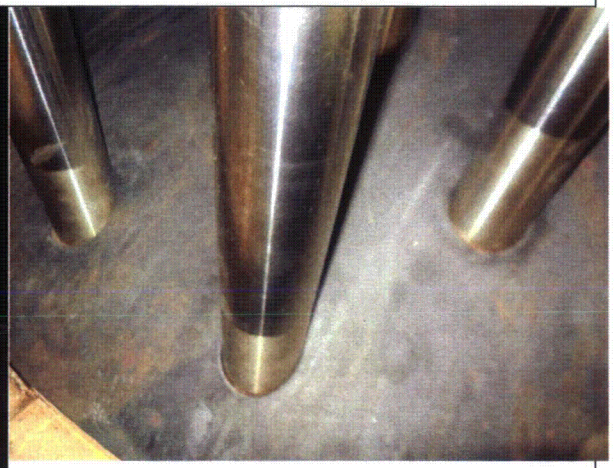
Ref. WO 551120-01 and GE Detailed RVI Report
RC-6: Clean Boric Acid and Inspect Reactor Vessel Closure Head

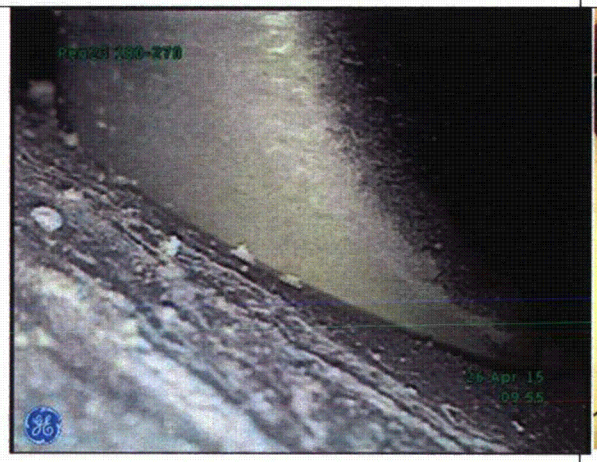
| CEDM Nozzle 18 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film on housing is from CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue. The yellow stain on the CEDM housing is indicative of CCW. A light dust residue and loose particles is shown to have settled in the annulus region on the upslope side of the penetration where it is relatively protected from air currents and cannot drift down slope in any vibration-induced drift. This residue extends downslope along the penetration sides where it has been able to drift down. Again, from this view there are no large deposits or any large stains. There is slight discoloration of the bottom of the nozzle and a very small accumulation of heavier residue in the down slope of the penetration, but neither is indicative of a BA leak source from the penetration.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

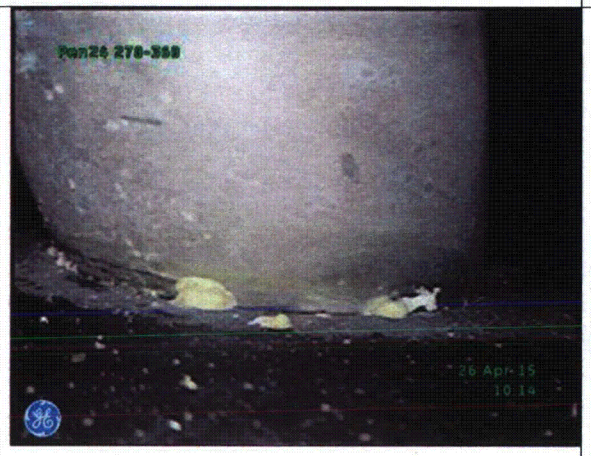
| CEDM Nozzle 19 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of possible Boric Acid deposits on side and base of entire penetration<br>(b) Relevant<br>**Question 2**<br>(b) Deposits show flow conditions from above and have a yellowish tint to them. Visible leakage showed flow from insulation above. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. See plan view of page one of Attachment 2. Post vacuuming VE showed no sign of degradation/nozzle leakage.<br>(c) See chemistry description at end of report.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

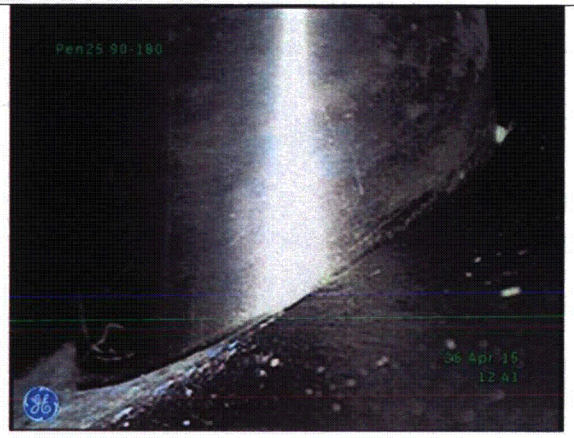
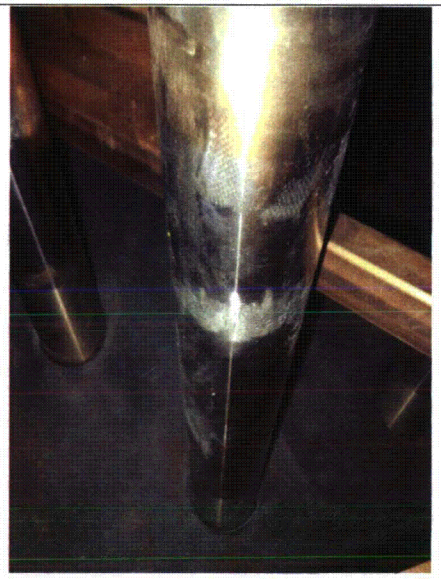
| CEDM Nozzle 20 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue. The 0-90 and 180-270 views show no accumulation of any residue on the upslope portion and sides of the penetration; the darker bare metal of the RVH is clearly apparent. The 90-180 view shows a light dusting of residue that has settled down slope in the protective lee ward side of the annulus, but there is no significant discoloration or any other indication of a leak source.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

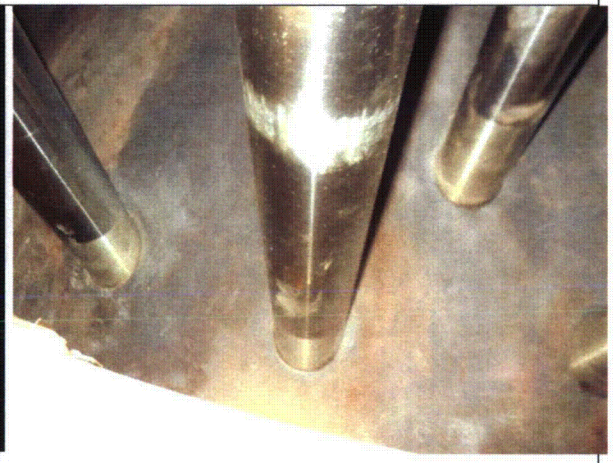
| CEDM Nozzle 21 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of possible Boric Acid deposits on base of penetration<br>(b) Relevant<br>**Question 2**<br>(b) Deposits indicate light dusting in a blowing fashion in the direction of 90-180 degree. Known RCS leak from RC-100 packing near CEDM #21 in the 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

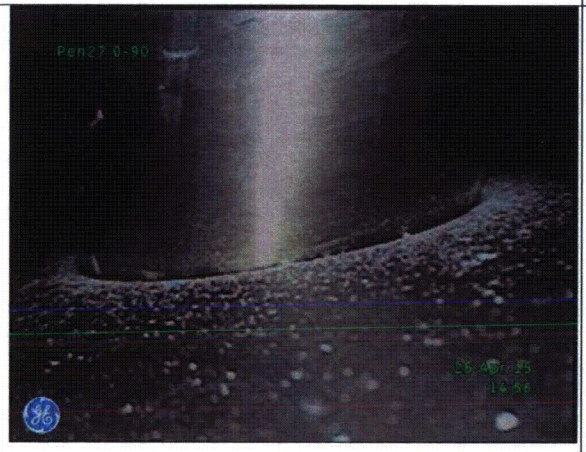
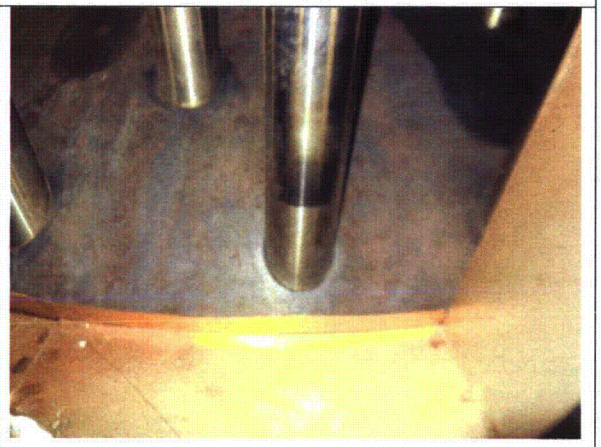
| CEDM Nozzle 22 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b) Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b) See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue. The 0-90 and 180-270 views show no accumulation of any residue on the upslope portion and sides of the penetration; the darker bare metal of the RVH is clearly apparent although there are a few small granules upslope of the penetration. These granules have settled there from circulation within the shroud; there is no leakage above which could have deposited them. The 90-180 view shows a light dusting of residue that has settled down slope in the protective leeward side of the annulus, and there is only slight discoloration of the nozzle in the 0-90 view.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

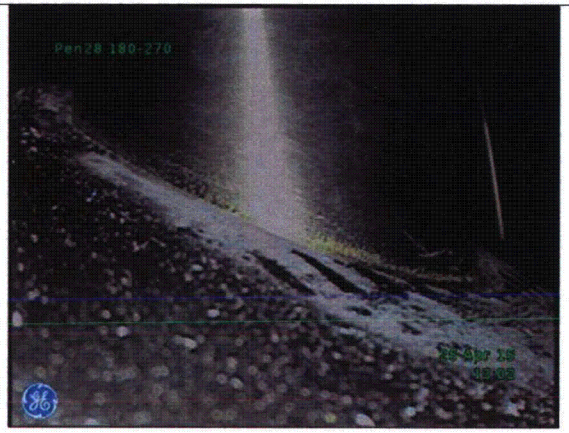
| CEDM Nozzle 23 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b) Relevant<br>**Question 2**<br>(b) Deposits indicate leakage flow down the head, past the penetration. The leak path is up the curvature of the head from the penetration. The leak source appears to be the known CCW leak from the flex hose near CEDM 3 and 8 in upper seal housing which is then flowing down the curvature of the head to Nozzle 23. See plan view for location<br>(c) See chemistry description at end of report.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

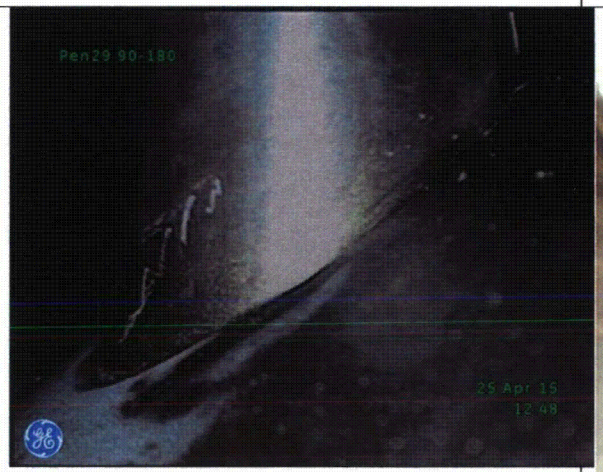
| CEDM Nozzle 24 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a) Indication of possible Boric Acid deposits on base of penetration<br>(b) Relevant<br>**Question 2**<br>(b) Deposits indicate leakage flow down the head past the penetration. The leak path appears to be up the curvature of the head from the penetration. The leak source appears to be the known CCW leak from the flex hose near CEDM 3 and 8 in upper seal housing. This appears to be flowing down CEDM 3 and 8, which is pooling on insulation.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 25 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration.<br>(b). Relevant<br>**Question 2**<br>(b). Deposits are of light dusting showing indication of being blown around penetration and collecting on one side.<br>(c) See chemistry description at end of report.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

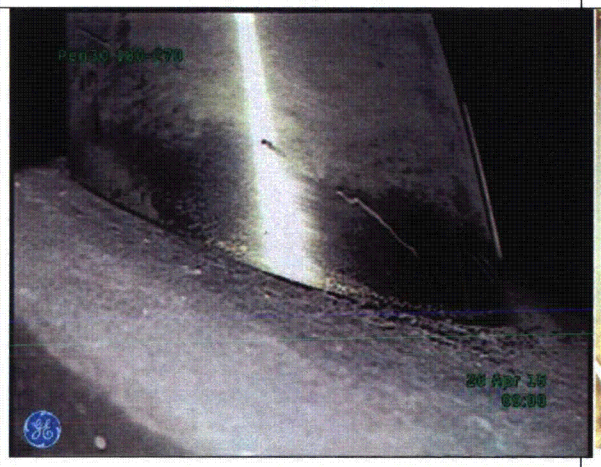
| CEDM Nozzle 26 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of small amounts of dust deposits on side and base of penetration. No corrosion. Yellow film is indicative of CCW.<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue. There is no residue shown on the sides or upslope portion of the penetration nozzle, although residue dust has collected down slope in the protective leeward side of the penetration and there are a few small granules pictured in the 270-360 view. There are no leaks from above; the granules appear to have settled after drifting downslope on the RVH. A series of white marks are visible in the 180-270 view that appear to be small scrapes with white BA dust residue caught in them. The penetration is very close to the edge of the RVH and ICI penetration 45. The scratch marks appear to have no depth and there is no leakage or staining originating from them or present in their vicinity. Neither these scrapes nor the dust accumulated could be masking any leak or deficiency.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

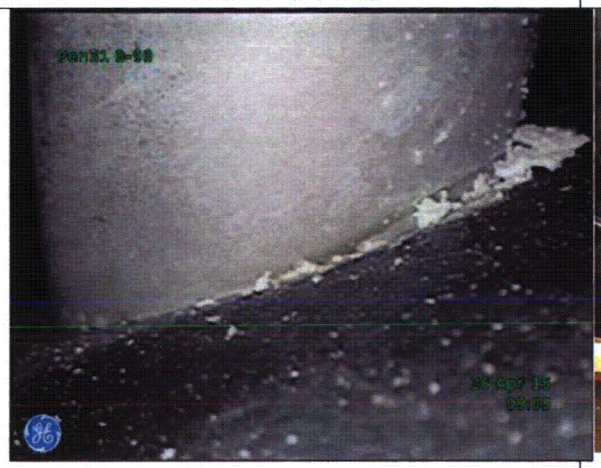
| CEDM Nozzle 27 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits are of light dusting show indication of being blown around penetration and collecting around the penetration. Known RCS leak from RC-100 packing near 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

| CEDM Nozzle 28 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits are of light dusting showing indication of being blown around penetration and collecting around the penetration. Known RCS leak from RC-100 packing near 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

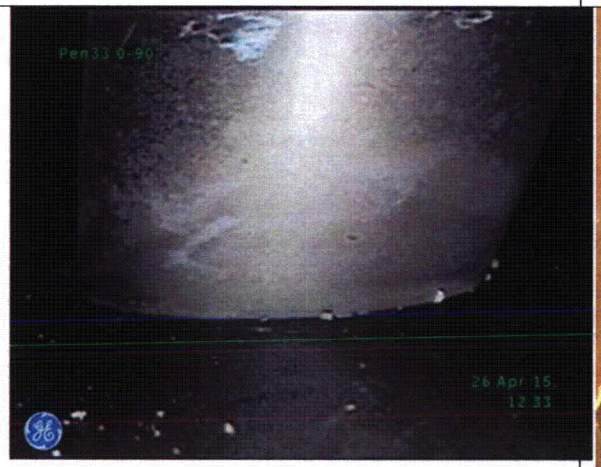
| CEDM Nozzle 29 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of small amounts of dust deposits on side and base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>The initial bare metal inspection photos document no large accumulations or deposits of residue. There is no residue shown on the sides or upslope portion of the penetration nozzle, although residue dust has collected down slope in the leeward side of the penetration. The residue has not settled directly in the annulus region. A white mark is visible in the 90-180 view that appears to be a small scrape with white BA dust residue caught in it. As the penetration is very close to the edge of the RVH and ICI penetration 47, the scratch was likely made by a foot or tool from personnel performing maintenance or installing insulation. The scratch mark appears to have no depth. There is light discoloration near the bottom of the nozzle, but neither this nor the dust accumulated could be masking any leak or deficiency.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

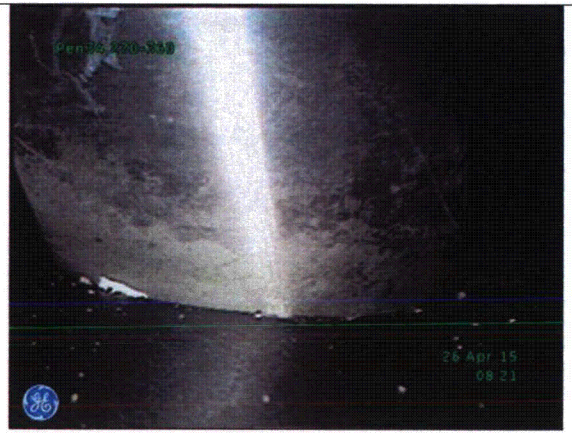
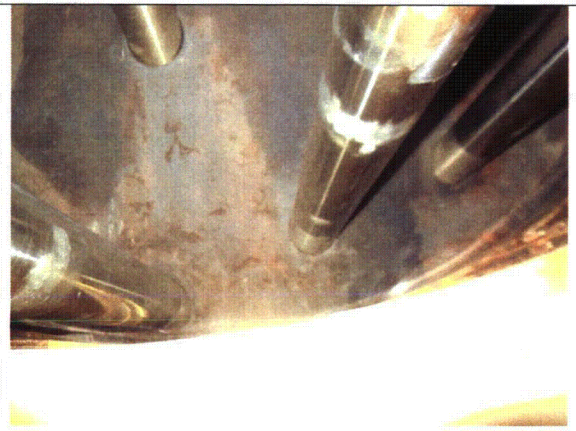
Ref. WO 551120-01 and GE Detailed RVI Report
RC-6: Clean Boric Acid and Inspect Reactor Vessel Closure Head

| CEDM Nozzle 30 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits are of light dusting showing indication of being blown around the penetration and collecting around the penetration. Known RCS leak from RC-100 peaking near 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

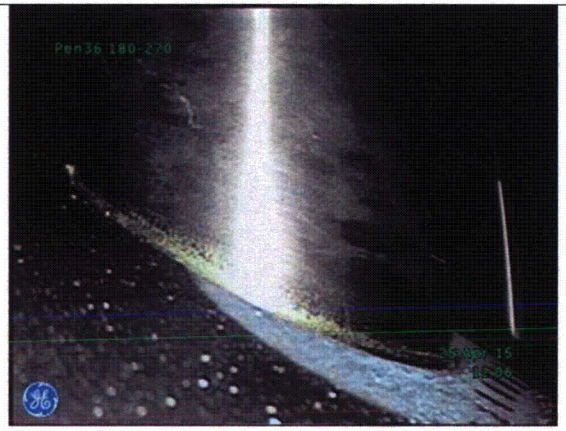
| CEDM Nozzle 31 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. The leak path is up the curvature of the head from the penetration. The leak source appears to be the known CCW leak from the flex hose near CEDM 3 and 8 in upper seal housing which is then flowing down the curvature of the head to Nozzle 31 above penetration #31 as a source. See plan view for location.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

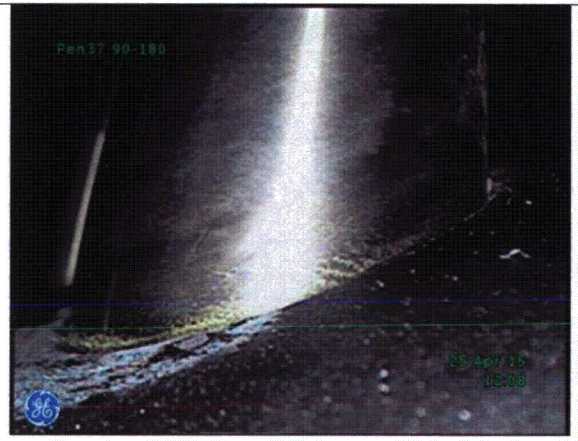
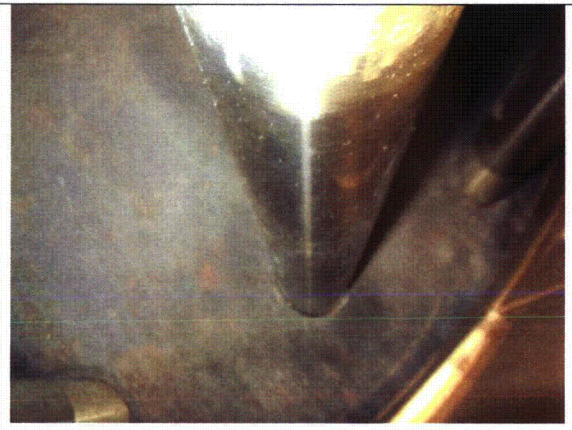
| CEDM Nozzle 32 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. The leak path is up the curvature of the head from the penetration. The leak source appears to be the known CCW leak from the flex hose near CEDM 3 and 8 in upper seal housing which is then flowing down the curvature of the head to Nozzle 32. See plan view for location<br>(c) See chemistry report at end of report<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 33 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. Leak path up the curvature of the head from the penetration. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. Flow from CCW flex hose leakage through penetrations above penetration #33 as source.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

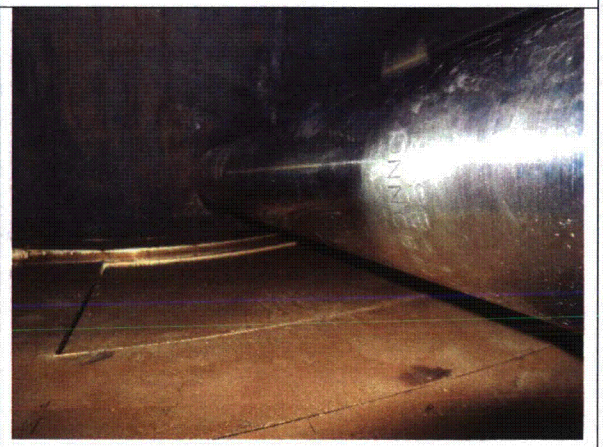
| CEDM Nozzle 34 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. Flow from CCW flex hose leakage through penetrations above penetration #34 as source<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

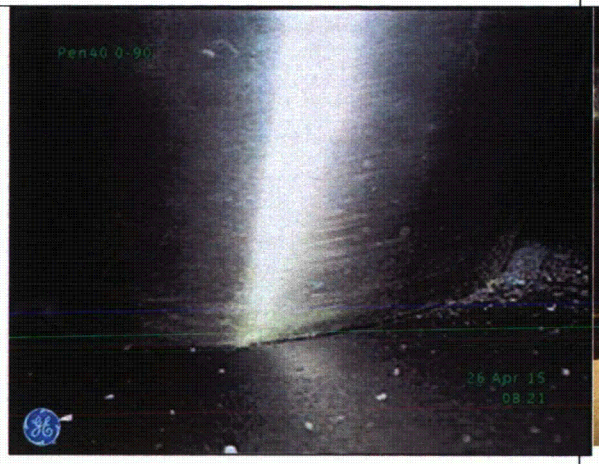
| CEDM Nozzle 35 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. Leak path up the curvature of the head from the penetration. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. Flow from CCW flex hose leakage through penetrations above penetration #35 as source.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 36 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate light dusting in a blowing fashion in the direction of 090-180 degree. Known RCS leak from RC-100 packing near CEDM #36 in the 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) See chemistry report at end of report<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

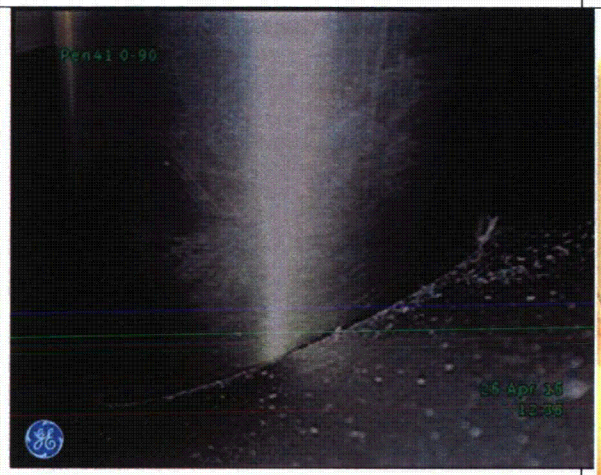
| CEDM Nozzle 37 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration.<br>(b). Relevant<br>**Question 2**<br>(b) Deposits indicate light dusting in a blowing fashion in the direction of 090-180 degree. Known RCS leak from RC-100 packing near CEDM #37 in the 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

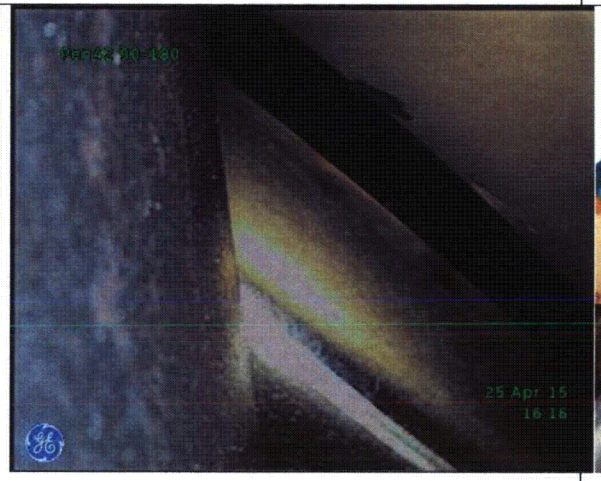
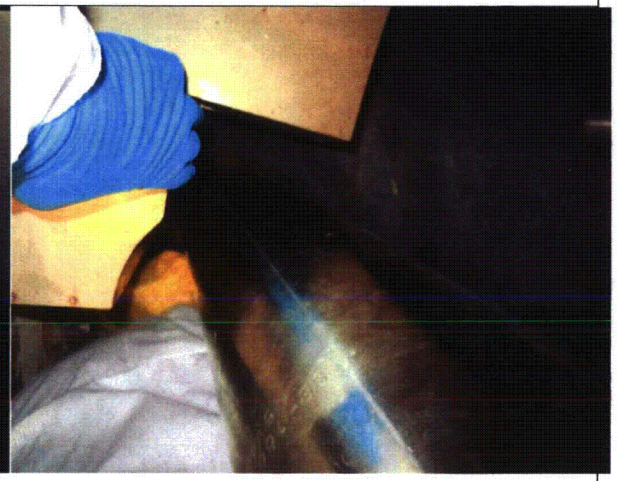
| CEDM Nozzle 38 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. Leak path from up the curvature of the head from the penetration. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. Flow from CCW flex hose leakage through penetrations above penetration #38 as source<br>(c) See Chemistry report at end of report<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

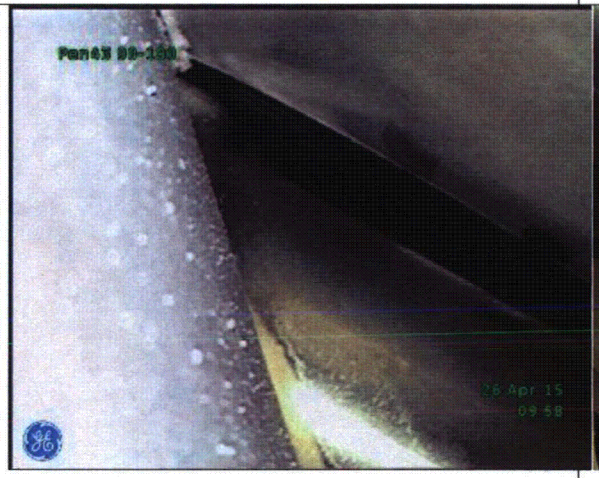
| CEDM Nozzle 39 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate leakage flow down the head past penetration. Leak path identified as up the curvature of the head from the penetration. Known CCW leak from flex hose near CEDM 3 and 8 in upper seal housing flowing down CEDM 3 and 8 and pooling on insulation and further leakage on reactor vessel head near surrounding penetrations. Flow from CCW flex hose leakage through penetrations above penetration #39 as source<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)* |  |  |

| CEDM Nozzle 40 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate light dusting in a blowing fashion in the direction of 180-270 degree. Known RCS leak from RC-100 packing near CEDM #40 in the 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

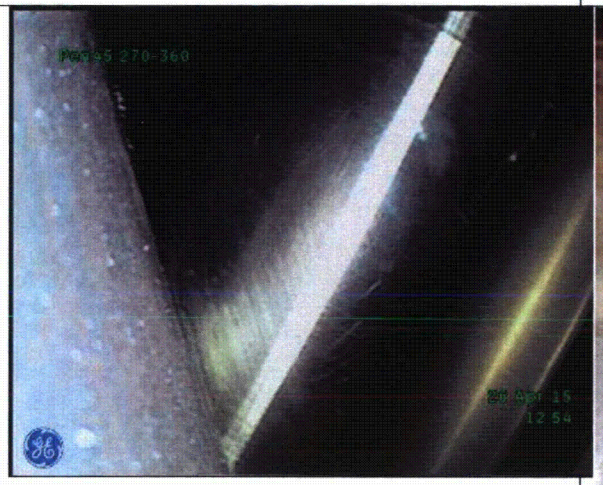
Ref. WO 551120-01 and GE Detailed RVI Report
RC-6: Clean Boric Acid and Inspect Reactor Vessel Closure Head

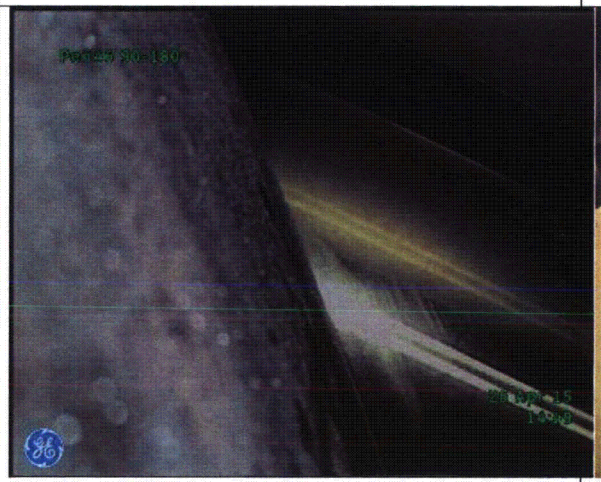
| CEDM Nozzle 41 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration<br>(b). Relevant<br>**Question 2**<br>(b). Deposits indicate light dusting in a blowing fashion in the direction of 090-180 degree. Known RCS leak from RC-100 packing near CEDM #41 in the 270-360 degree direction. Dusting due to blown leakage from RC-100.<br>(c) Sample not performed.<br>**Question 3**<br>N/A - Relevant<br>**Question 4**<br>N/A – Relevant with an evaluation per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)* |  |  |

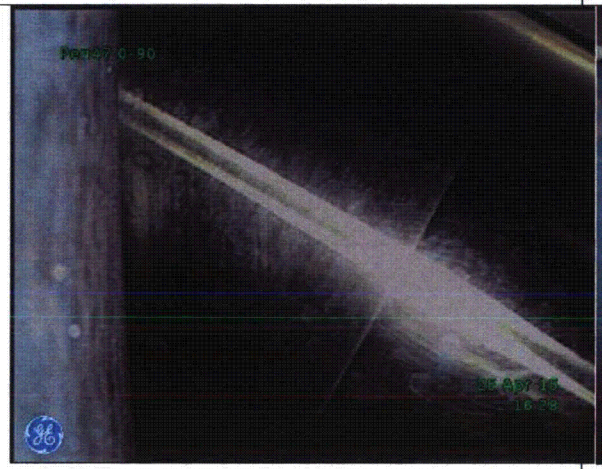
| ICI Nozzle 42 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible light amount of Boric Acid deposits around base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c). Sample not performed.<br>**Question 3**<br>The angle of the slope around penetration 42 is very steep which would allow deposits from above to easily collect around it. The deposits found were light and the deposits near the annulus were from the high point of the RVCH sloop around nozzle 42.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

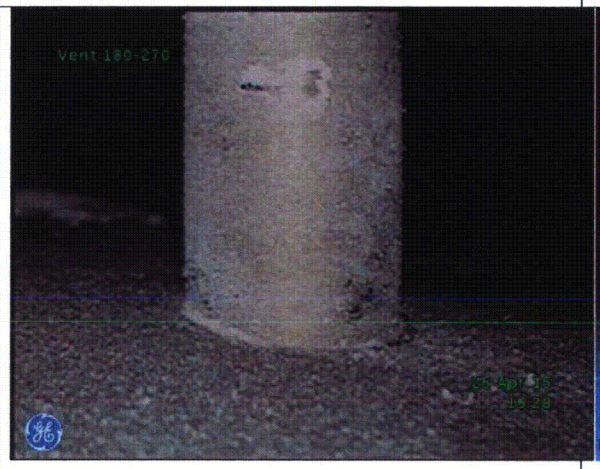
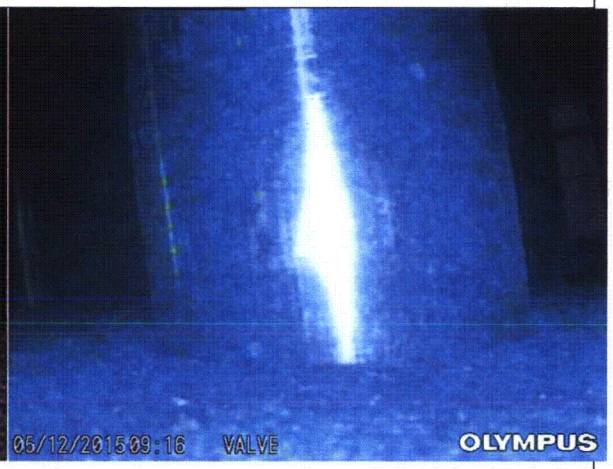
| ICI Nozzle 43 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible medium amount of Boric Acid deposits on base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c). Sample not performed.<br>**Question 3**<br>The angle of the slope around penetration 43 is quite steep which would allow deposits from above to easily collect around it. The deposits found were medium amount and the deposits near the annulus were from the high point of the RVCH sloop around nozzle 43. This would be expected for the amount of deposits above penetration around Nozzle 3 and 8.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

| ICI Nozzle 44 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible Boric Acid deposits on base of penetration and side.<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c). Sample not performed.<br>**Question 3**<br>The angle of the slope around penetration 44 is quite steep which would allow deposits from above to easily collect around it. The deposits found were light and the deposits near the annulus were from the high point of the RVCH sloop around nozzle 44. The indication on the side of the nozzle shows leak path to the ICI 44 mechanical leakage above the insulation and is the source.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined ICI-44 mechanical leak*<br>*Post Cleaning VE determined acceptable* |  |  |

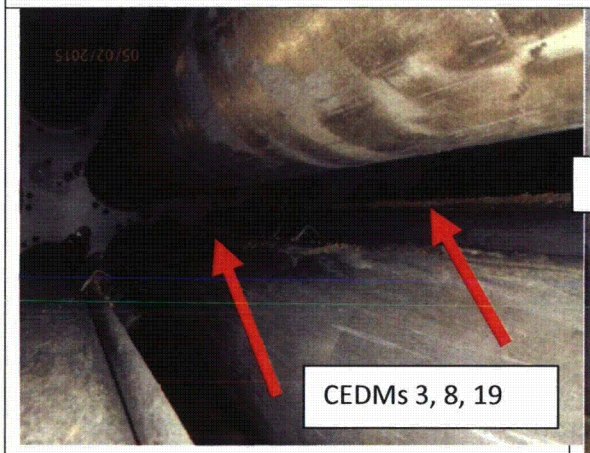
| ICI Nozzle 45 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible light amount of Boric Acid deposits on base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c). Sample not performed.<br>**Question 3**<br>The angle of the slope around penetration 45 is quite steep which would allow deposits from above to easily collect around it. The deposits found were a very light amount and the deposits near the annulus were from the high point of the RVCH sloop around nozzle 45.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

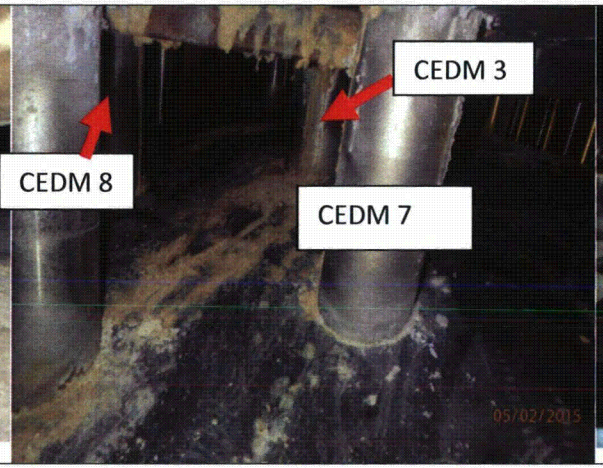
| ICI Nozzle 46 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible light Boric Acid deposits on base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c). Sample not performed.<br>**Question 3**<br>The angle of the slope around penetration 46 is quite steep which would allow deposits from above to easily collect around it. The deposits found were of light amount and the deposits near the annulus were from the high point of the RVCH sloop around nozzle 46. This would be expected for the accumulation of loose deposits above nozzle at Nozzle 21<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

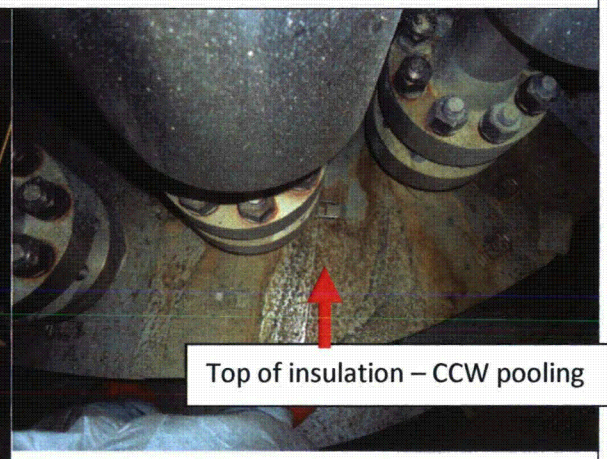
| ICI Nozzle 47 | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible light Boric Acid deposits on base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c). Sample not performed.<br>**Question 3**<br>The angle of the slope around penetration 47 is quite steep which would allow deposits from above to easily collect around it. The deposits found were of a very light amount and no deposits near the annulus. This would be expected for the amount of deposits above penetration around Nozzle 37.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined RC-100 packing leak (WO #551054)*<br>*Post Cleaning VE determined acceptable* |  |  |

| Vent Penetration | As-Found | As-Left |
|---|---|---|
| **Question 1**<br>(a). Indication of possible heavy Boric Acid deposits on base of penetration<br>(b). Initial Evaluation as Not Relevant later re-evaluated as Relevant<br>**Question 2**<br>(b). See Answer 3<br>(c) Sample not performed.<br>**Question 3**<br>Deposits on the side and base of RC-100 penetration. Visual leak path could be traced to above annulus towards the insulation where CCW was pooled from flex hose leak around CEDM 3 and 8.<br>**Question 4**<br>See Answer 3 for basis of not evaluating per -3142.1(b)(1) of CC N-729-1<br>*Leak Source determined CCW Flex Hose leak near CEDM 3/8 (WR #224908)*<br>*Post Cleaning VE determined acceptable* |  |  |

## CCW Flex Hose Leakage down CEDM

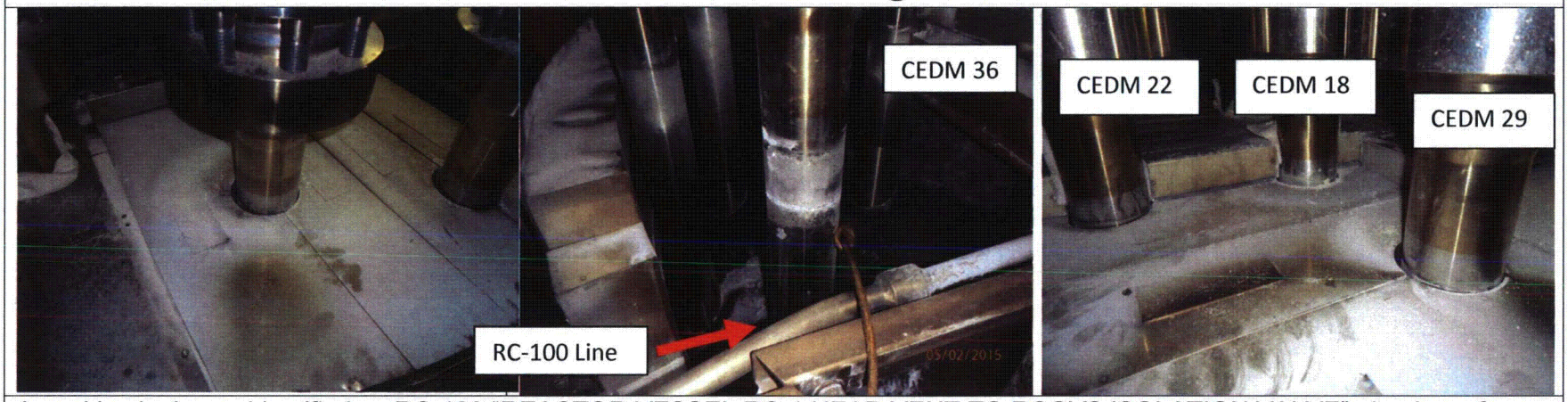



Component Cooling Water is supplied and returned by a ring header as part of the reactor vessel head work platform. The subject hoses supply and return CCW flow between the CEDM seal assemblies and the ring headers for CEDM cooling. One of the CCW hoses running between CEDMs 3, 7, 8, and 19 developed a leak during the operating cycle. Due to the hose being located above the reactor vessel closure head, the leakage was able to flow onto the surface below the CEDM Drive Assemblies and down the CEDM housings. Evidence of pooling on the top of insulation surface was identified. From this surface, the fluid was able to run down the CEDM housings through insulation and onto head.

## RC-100 Leakage




A packing leak was identified on RC-100 "REACTOR VESSEL RC-1 HEAD VENT TO RCGVS ISOLATION VALVE". Leakage from the packing of this valve results in RCS leakage and subsequent boric acid deposits around the area of the valve. Deposits from the valve packing, combined with other sources, contribute to the overall dust deposits located on the insulation layers and vent piping. Air circulation within the RVH shroud allows for redistribution of light deposit debris.

**Chemistry Description**
Samples were taken around the base of the penetration for the above noted nozzles. Samples were taken by removing deposits around selected areas.

The testing completed were analyses for the presence of boron, pH, tolyltriazole and isotopic. The boric acid, used for reactivity control in the RCS contains boron, the CCW corrosion inhibitor additive, CorrShield NT4204 contains sodium borate. The analysis performed at FCS for boron cannot differentiate between boron and borate, both show up as boron. Historically known CCW deposits have shown boron as high as 200ppm and known boric acid samples 900 ppm and much greater. The pH is a key indicator as well with boric acid samples <6. All sample pH's were >9 which would be improbable if boric acid were the predominate species. The isotopic ratios of the samples with enough volume to count were typical of the general contamination found in containment and show that there is no evidence of fresh RCS leakage. Tolyltriazole only originates in the CCW system.

The sum of the sample evidence shows that the predominate plant species in the deposits is not boric acid. If present it would have to be a minor constituent. It cannot be conclusively said that no boric acid is present.

Ref. WO 551120-01 and GE Detailed RVI Report
RC-6: Clean Boric Acid and Inspect Reactor Vessel Closure Head

# Response to Request for Additional Information
# Question #6 Regarding Fort Calhoun
# Relief Request RR-14

## RECORD OF REVISIONS

| Rev. | Description | Prepared by Date | Checked by Date | Reviewed by Date | Approved by Date |
|---|---|---|---|---|---|
| 0 | Original Issue | K.J. Fuhr 5/12/2015 | G.A. White 5/12/2015 | G.A. White 5/12/2015 | G.A. White 5/12/2015 |

The last revision number to reflect any changes for each section of the technical note is shown in the Table of Contents. The last revision numbers to reflect any changes for tables and figures are shown in the List of Tables and the List of Figures. Changes made in the latest revision, except for Rev. 0 and revisions which change the technical note in its entirety, are indicated by a double line in the right hand margin as shown here.

## CONTENTS

# 1 INTRODUCTION

The purpose of this technical note is to provide a response to a specific request for additional information (RAI) item transmitted by the U.S. NRC to Omaha Public Power District (OPPD) regarding relief request number RR-14 [1]. This relief request proposes an alternative to the requiremnents of ASME Code Case N-729-1 [2] as conditioned by 10 CFR 50.55a(g)(6)(ii)(D) with regard to acceptance of visual examination results for the upper surface of the reactor vessel closure head (RVCH) for the current refueling outage at Fort Calhoun. The alternatives are proposed to be applied during the next operating cycle and will conclude in the refueling outage scheduled to begin the fall 2016.

# 2 RAI QUESTION NO. 6

Question #6 of the RAI transmitted by the U.S. NRC states:

> *Page 3 of the relief request states, "...There is no evidence of a flaw in any of the RVH [reactor vessel head] nozzles or partial penetration welds; therefore, performing emergent supplemental examination and/or repair/replacement of the nozzles does not result in a compensating increase in the level of quality or safety..." The NRC staff questions that there is no evidence of relevant conditions indicative of possible nozzle leakage because the NRC questions the effectiveness of the licensee's disposition of the relevant conditions. As such, the NRC staff is concerned regarding the potential for nozzle ejection or significant degradation of the low alloy steel reactor vessel head due to boric acid corrosion if the nozzles with relevant conditions are allowed to remain in service. Therefore, provide technical basis to demonstrate that nozzle ejection or a loss of upper head structural integrity will not occur during the duration of this proposed alternative. If the licensee has performed calculations to address the level of quality or safety for the proposed alternative, the NRC staff notes that the time to leakage, given the short operational lifetime of the current reactor vessel head would not provide a sufficient basis for crack growth rate improvement factors due to the use of alloy 690 or its weld materials.*

# 3 RESPONSE TO RAI QUESTION 6

## 3.1 Concern for Nozzle Ejection

The potential concern for nozzle ejection is evaluated using Table 3-1 of Electric Power Research Institute (EPRI) Materials Reliability Program report MRP-395 [3]. This table shows the results of several representative calculations for the time for growth of an initial 30° through-wall circumferential to reach a circumferential extent of 300°, which is a conservatively small measure of the critical size for nozzle ejection. These calculations are for Alloy 600 nozzles, and thus they take no credit for the factors of improvement for Alloy 690/52/152 materials observed in laboratory testing [4]. In addition, these calculation results conservatively reflect application of a factor of 2 on the PWSCC crack growth rate to account for the potential effect of chemical concentration on the nozzle OD. For a head temperature of 605°F, the lower bound time for circumferential crack growth in MRP-395 [3] is 7.4 EFPYs. Because the calculation cases in Table 3-1 of MRP-395 [3] are representative of top head nozzle geometries in the U.S. PWR fleet, the minimum calculated growth time from this table is expected to be bounding for the Fort Calhoun top head nozzle geometries.

At the head temperature for Fort Calhoun of 588°F ([5], [6]),[1] this crack growth time corresponds to 11.4 EFPYs (using the standard Arrhenius temperature dependence and the standard activation energy of 31 kcal/mole for PWSCC crack growth per ASME Code Case N-729-1 [2]). A period of 11.4 EFPYs is greater than the total operating time of 6.56 EFPY [7] for the replacement head from the time of replacement in 2006 projected until the time of the next refueling outage scheduled to begin the fall 2016 (i.e., the end of the period for the requested alternative). Thus, even without crediting any time for crack initiation and through-wall penetration and even without crediting the improved performance of Alloys 690/52/152 versus Alloys 600/82/182, nozzle ejection is shown to be precluded during the duration of the proposed alternative.

## 3.2 Concern for Boric Acid Corrosion of Low-Alloy Steel

The potential concern for boric acid corrosion due to leakage through the penetration nozzle tube and/or attachment weld is evaluated on the basis of the extensive mockup testing and analyses documented in a series of EPRI MRP reports. These reports include MRP-110 [8], MRP-117

[1] Because reactor thermal power and reactor cold-leg temperature are nominally the same for the replacement head as for the original head in 2001, the MRP-48 [5] operating head temperature value of 588°F still applies to the replacement head [6].

[9], MRP-308 [10], MRP-375 [11], and MRP-395 [3]. This work demonstrates that more than a single fuel cycle of operation (i.e., more than 24 months of operation) is necessary to produce structurally significant corrosion of the low-alloy steel head given a leaking Alloy 600 nozzle. These assessments do not credit the crack growth rate factors of improvement for Alloy 690/52/152 materials observed in laboratory testing [4]. The visual examinations performed during the current refueling outage revealed no discernible wall loss of the low-alloy steel head material ([1], [7]). Thus, assuming that a nozzle was leaking prior to the current refueling outage, the potential boric acid corrosion effects of such leakage would be in its earliest stages. Thus, even without crediting the improved performance of Alloys 690/52/152 versus Alloys 600/82/182, a loss of upper head structural integrity is shown to be precluded during the duration of the proposed alternative.

# 4 REFERENCES


1. Letter from L. P. Cortopassi (OPPD) to U.S. NRC, "Relief Request Number RR-14, Request for Relief from Paragraph -3142.1(c) of ASME Code Case N-729-1 for Reactor Vessel Head Penetration Nozzle Welds," LIC-15-0066, dated May 9, 2015.
2. ASME Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1," Approved March 28, 2006.
3. *Materials Reliability Program: Reevaluation of Technical Basis for Inspection of Alloy 600 PWR Reactor Vessel Top Head Nozzles (MRP-395)*. EPRI, Palo Alto, CA: 2014. 3002003099. [Freely available at www.epri.com]
4. Memo from M. Srinivasan (U.S. NRC-RES) to D. W. Alley (U.S. NRC-NRR), "Transmittal of Preliminary Primary Water Stress Corrosion Cracking Data for Alloys 690, 52, and 152," October 30, 2014. [NRC ADAMS Accession No. ML14322A587]
5. *PWR Materials Reliability Program Response to NRC Bulletin 2001-01 (MRP-48)*, EPRI, Palo Alto, CA: 2001. 1006284. [Freely available at www.epri.com]
6. Email from M. Bare (OPPD) to G. White (DEI) , "RE: head temp: Comparison new head to old?," dated May 12, 2015.
7. Email from J. McManis (OPPD) to G. White (DEI) , "Request for documentation FW: head temp: Boron Deposit Characterization," dated May 12, 2015.
8. *Materials Reliability Program: Reactor Vessel Closure Head Penetration Safety Assessment for U.S. PWR Plants (MRP-110NP): Evaluations Supporting the MRP Inspection Plan*, EPRI, Palo Alto, CA: 2004. 1009807-NP. [ML041680506]

9. *Materials Reliability Program: Inspection Plan for Reactor Vessel Closure Head Penetrations in U.S. PWR Plants (MRP-117)*, EPRI, Palo Alto, CA: 2004. 1007830. [Freely Available at www.epri.com]

10. *Materials Reliability Program: Boric Acid Corrosion Testing: Implications and Assessment of Test Results (MRP-308)*, EPRI, Palo Alto, CA: 2011. 1022853. [Freely Available at www.epri.com]

11. *Materials Reliability Program: Technical Basis for Reexamination Interval Extension for Alloy 690 PWR Reactor Vessel Top Head Penetration Nozzles (MRP-375).* EPRI, Palo Alto, CA: 2014. 3002002441. [Freely Available at www.epri.com]