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December 2, 2003
L-03-191

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

Subject: **Beaver Valley Power Station, Unit No. 1 and No. 2**
BV-1 Docket No. 50-334, License No. DPR-66
BV-2 Docket No. 50-412, License No. NPF-73
NRC Bulletin 2003-02
BV-2 Lower Head Inspection 60-Day Report

References:

1. NRC Bulletin 2003-02: Leakage from Reactor Pressure Vessel Lower Head Penetrations and Reactor Coolant Pressure Water Boundary Integrity dated August 21, 2003
2. NRC Bulletin 2003-02 Response for Beaver Valley Power Station (BVPS), L-03-138, dated September 19, 2003

During the recent BVPS Unit 2 2R10 Refueling Outage, a visual inspection of the reactor pressure vessel (RPV) lower head penetrations was performed. This inspection was conducted per the BVPS response (Reference 2) to NRC Bulletin 2003-02 (Reference 1). In accordance with the Bulletin, a 60-day report, detailing the inspection results is being provided. The BVPS Unit 2 Evaluation Report for 2R10 is enclosed as Attachment 1 to this letter. As requested, this Report also includes responses to the NRC questions discussed during BVPS/NRC teleconferences held on September 25 and October 8, 2003.

Attachment 2 provides a list of commitments made in this document. If there are any questions concerning this matter, please contact Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement at 724-682-5284.

Sincerely,

L. William Pearce

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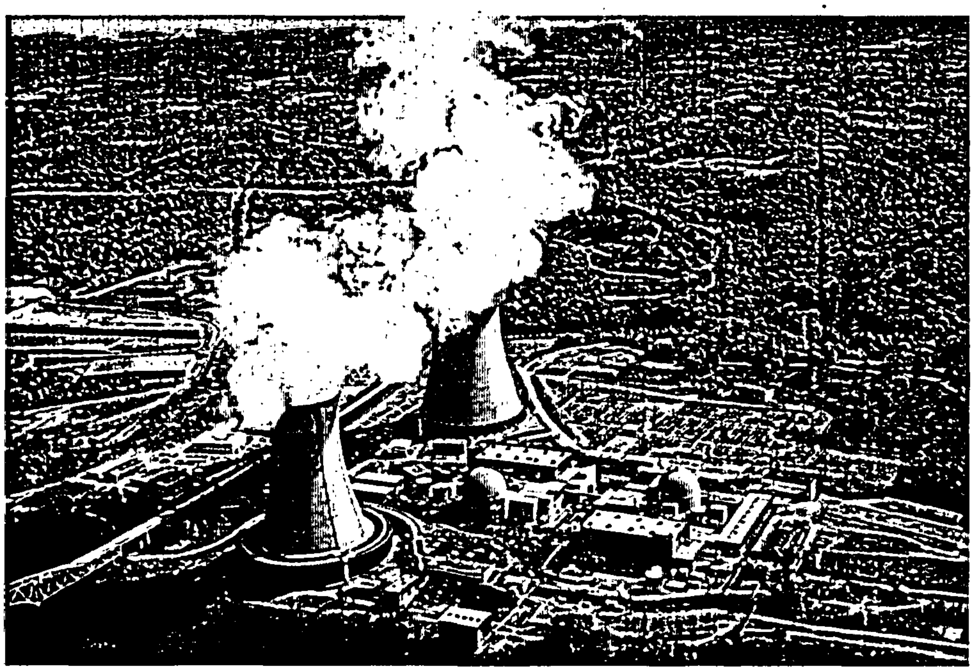
Attachments

c: Mr. T. G. Colburn, NRR Senior Project Manager
Mr. P. C. Cataldo, NRC Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator

Attachment 1

NRC Bulletin 2003-02
Beaver Valley Power Station Unit 2

FirstEnergy Nuclear Operating Company (FENOC)



Evaluation Report for 2R10

Inspection

of

Beaver Valley Unit 2

RPV Lower Head Penetrations

(Ref: NRC Bulletin 2003-02)

November 2003

Introduction

The visual inspection of the Beaver Valley Power Station (BVPS) Unit 2 Reactor Pressure Vessel (RPV) lower head penetrations during the recent 2R10 refueling outage was performed as part of a commitment made to NRC Bulletin 2003-02, "Leakage from Reactor Pressure Vessel Lower Head Penetrations and Reactor Coolant Pressure Boundary Integrity." Bulletin 2003-02 was issued on August 21, 2003 following the discovery of two leaking RPV lower head penetrations at South Texas Project Unit 1 during the spring of 2003. The Reactor Coolant System (RCS) leakage was determined to have resulted from through-wall axial indications in the Alloy 600 tube material.

The BVPS Unit 2 commitment to Bulletin 2003-02 for 2R10 was to perform a visual inspection of all 50 BMI penetrations including 100% of the circumference of each penetration as it enters the RPV lower head to the maximum extent practical. The visual inspection was designed to detect indications of leakage from any of the RPV lower head penetrations.

RPV Lower Head Configuration

The BVPS Unit 2 reactor vessel lower head contains 50 BMI penetrations fabricated from two different heats of Alloy 600 tube material supplied by Huntington Alloys. The penetrations have an outer diameter of 1.5" and are clearance fit into the bottom of the reactor vessel. The tubes are attached to the vessel by an Alloy 82/182 attachment weld on the inside diameter surface of the vessel.

Inspection Technique

The visual inspection of the RPV lower head penetrations was accomplished using a vendor's remote camera crawler. Access to the penetrations was achieved from two locations 180° apart where fixed mirror insulation panels were removed. The remote crawler, equipped with a pan and zoom (~20x) camera, rode on the horizontal surface of the insulation to provide a view of the penetration annulus from almost directly underneath each penetration.

The visual exam was documented on videotape. The exam used the same indexing protocol as is common on remote visual exams of the top of the RPV head. Each of the 50 penetrations was divided into 4 quadrants (A, B, C, and D). Video footage and still images were obtained of all 200 quadrants inspected. The visual exam was reviewed in-situ using either FENOC Level II or III VT-2 examiners. The examiners' observations for each quadrant were logged as part of the vendor's site specific procedure.

Inspection Results

The visual inspection found no indications characteristic of RCS through-wall leakage or boric acid accumulation around any of the 50 RPV lower head penetrations. The VT-2 examiner logs did identify the presence of material (debris), on and around the RPV lower head penetration area of interest. This condition was noted on 29 quadrants of 18 penetrations (See Figure 1). Similar debris was also noted on the vessel surface and boss surface around virtually every penetration (See Figure 2). Visual evidence from the inspection video indicates that the debris appears to be adhesive residue from tape that had been removed at some point during plant construction. Supplemental evaluation and follow-up chemical analysis performed on samples concluded that the residue was from tape used in the packaging and shipment of the reactor vessel. The results of the evaluation were identified in the BVPS Corrective Action Program (Condition Report # 03-09647). A summary of the supplemental evaluation and follow-up chemical analysis is provided in the following sections of this report.

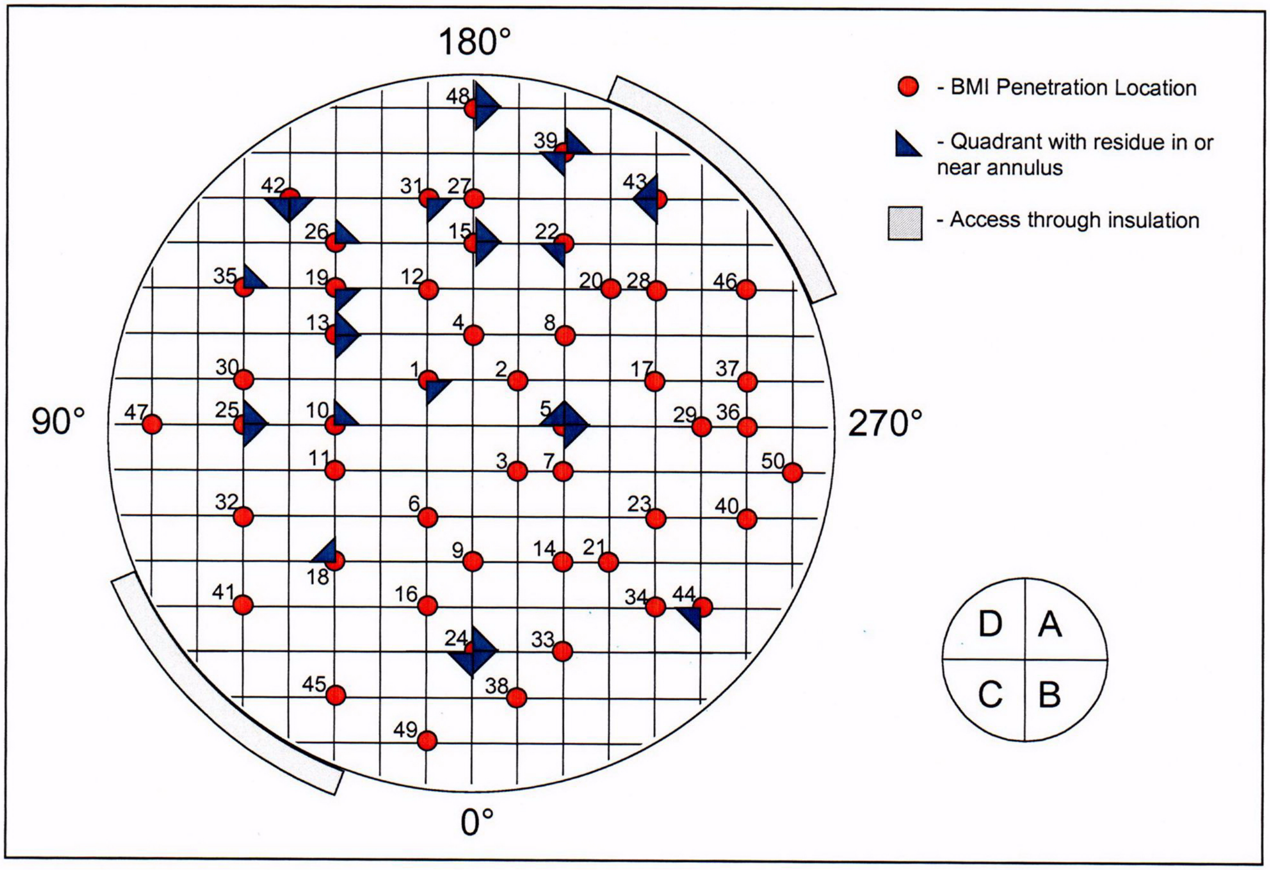


Figure 1: Locations of residue observed in or near penetration annulus.

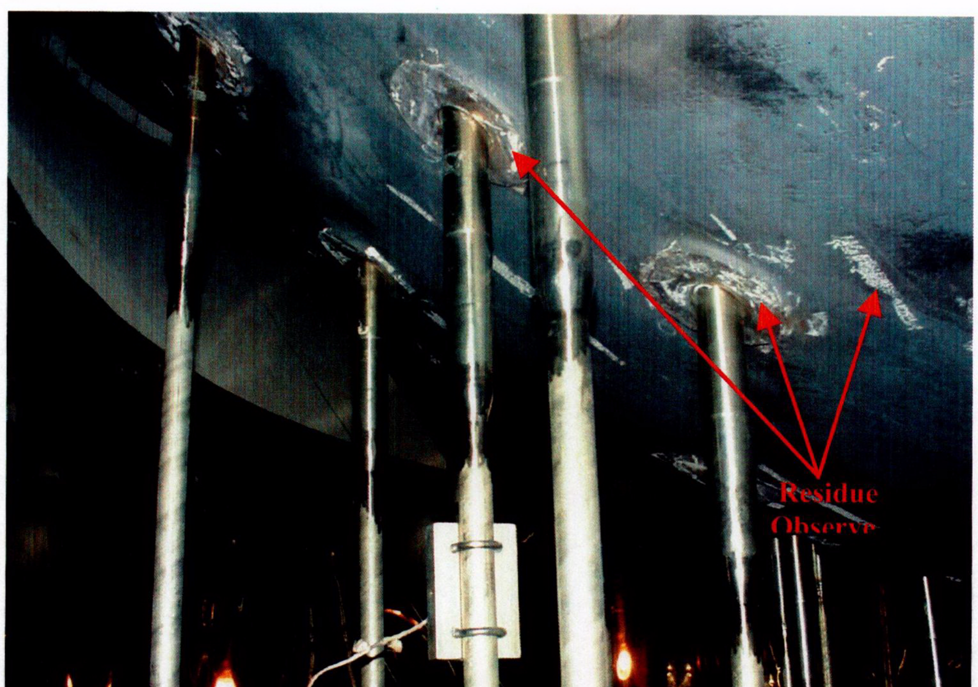


Figure 2: BVPS Unit 2 lower head observed during 2R10.

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Supplemental Evaluation

Initial Sampling and Analysis

After reviewing the visual examination results, the decision was made to obtain a sample of the material, which was assumed to be tape residue. The sample was confirmatory in nature, as all visual evidence indicated a condition not consistent with RCS leakage or boric acid accumulation. Figure 2 shows a general area of the BVPS Unit 2 lower head.

Samples were obtained from Penetrations 29 and 43 to be analyzed for the presence of boron and lithium, the presence of which would indicate that the material had once been in the RCS. The sample from Penetration 29 was taken by wiping the residue from the surface of the boss around the penetration. The sample from Penetration 43 was obtained using a small pick to remove the material from the annulus. The material was not strongly adhered to the surface (when touched during the sampling process, the material in the annulus of Penetration 43 fell off easily). Figure 3 shows the locations on Penetrations 29 and 43 from which samples were obtained.

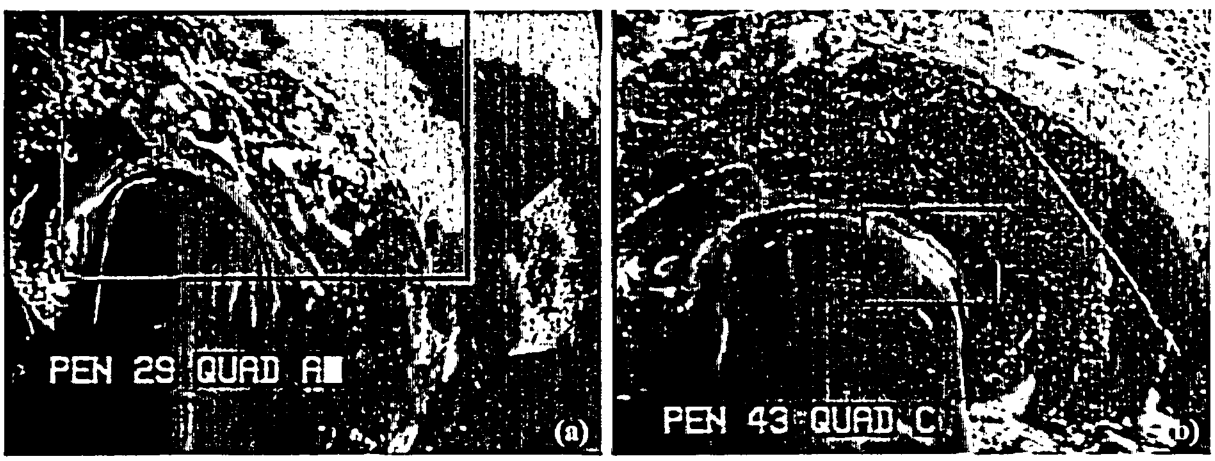


Figure 3: Initial sampling areas of Penetrations 29-A Boss (a) and 43-C (b).

The samples taken from Penetrations 29 and 43 were tested by the BVPS Chemistry Department for the presence of boron and lithium. Analysis for boron was performed using an Inductively Coupled Plasma (ICP) Spectrometer. Lithium analysis was performed using an Atomic Absorption Spectrometer (AA). The chemical analysis of both samples showed boron and lithium concentrations of less than 0.1ppm, the lower detection-limit in each case. Furthermore, the penetration residue appeared to be a glue-like substance, beige in color and was insoluble in water. The overall conclusion was that the residue did not contain detectable amounts of boron or lithium and was not characteristic of RCS leakage or boric acid accumulation.

Follow-up Sampling and Analysis

Following a conference call between BVPS and representatives from NRC Region 1 and NRR on 9/25/03, an attempt was made to obtain additional samples of the residue observed during the visual examination. This was done to address two primary areas of concern:

1. To provide added assurance that the material sampled is chemically representative of the 18 penetrations that exhibited residue in or near the annulus between the penetration and the vessel.

2. To determine the chemical composition of the material (beyond boron and lithium content) to ensure that the residue does not contain unacceptable levels of elements that could be deleterious to the vessel or penetration materials (i.e. halogens, heavy metals, etc.)

To address Item 1, additional samples were obtained from the annulus of Penetration Quadrants 18-D and 25-B, two of the quadrants identified during the visual exam as possessing residue in or near the annulus. Penetrations 18 and 25 were also chosen because they were physically accessible given the insulation panels that had already been removed.

For Item 2, a bulk sample was taken by scraping residue from the vessel and boss surface around Penetration 17. This was done in an attempt to obtain a sample large enough to perform a full chemical analysis. Figure 4 shows the locations on Penetrations 18, 25, and 17 from which samples were obtained.

The samples obtained from the annuli of Penetrations 18 and 25 proved to be too small for the BVPS onsite Chemistry Department to perform an analysis for boron and lithium. In addition, BVPS does not have the onsite capability to perform a full chemical analysis, as was desired for the sample from the area around Penetration 17. As such, all three samples were transported to the Westinghouse Science and Technology Department for analysis.

The weights of the three additional samples were 0.8mg (Penetration 18), < 0.8mg (Penetration 25), and 60mg (Penetration 17). The laboratory requires 1 gram of material to perform bulk testing for heavy metals and anions. As a result, chemical characterization was performed using a Scanning Electron Microscope (SEM).

Figure 4: Follow-up sampling of Penetrations 18-D (a), 25-B (b), and 17-A Boss/Vessel (c).

Elemental analysis on the three additional samples was performed using Scanning Electron Microscope – Energy Dispersive X-ray Spectroscopy (SEM-EDS). The instrument used was an Amray 1830I with a Kevex Quantum Delta 3IA energy dispersive X-ray detector. The EDS detector was operated by a Thermo Noran Quest system, which can detect all elements heavier than boron.

Three tables are provided on the following pages for comparison purposes. Table 1 describes the physical properties of and elements present in the materials used for packaging and shipping of the reactor vessel lower head. Table 2 shows the elements present in the materials that make up the reactor vessel lower head and penetration tubes. Table 3 characterizes the samples tested in terms of elements present in detectable amounts using SEM-EDS. (Tables and descriptions are extracted from Westinghouse Letter "Chemical Analysis of Beaver Valley 2 Bottom Head Residue," November 6, 2003).

The major elements identified in the residue scraped from the bottom of the reactor vessel are consistent with elements present in the materials used in the packaging and shipping of the reactor vessel and/or the materials used to fabricate the lower head and penetration tubes. Random trace elements identified in some of the analyses (V, Y, Mo) are likely the result of impurities present in the packaging materials.

There are no detrimental elements present, with the exception of sulfur. There is a small amount of sulfur in the materials used to fabricate the lower head and penetration tubes. Sulfur is also present as a sulfonate in the Spraylat coating. Sulfur, however, is only present at less than or equal to 0.20 weight percent in the removed particles. As the sulfur is located in a non-aqueous environment, its presence does not create a detrimental effect.

Table 1: Elements Present in Materials Used in Packaging/Shipment of the Reactor Vessel

Material	Description	Color	Elements Present
Cheesecloth	Cotton fibers		C, O
3M 481 tape	Polyethylene plastic backing with rubber resin adhesive	Black	C polyethylene additives unknown
3M 698 filament reinforced tape	Polyethylene plastic reinforced with glass yarn filaments	Unknown	C, O, Al, Ca, Si, Fe (possibly also Mg, Na, K, Ti)* polyethylene additives unknown
Spraylat SC-1047B-2	Strippable plastic coating	Black	C, O, Zn, Cr, S
Spraylat SC-1090	Strippable plastic coating	White	C, O, S, 5-10 % Titanium dioxide
Carbolene	Modified silicone, may be applied over an inorganic zinc primer such as Carbo Zinc 11	Aluminum and black	C, O, Si, Zn

* composition of "E" glass (electrical grade glass fiber) used as reference

Titanium dioxide is also commonly used as a white pigment in some plastic formulations.

Table 2: Elements Present (Wt. %) in the Reactor Vessel Bottom Head and Penetration Tubes at Beaver Valley Unit 2

Heat ID	Heat #	C	Mn	Fe	S	Si	Cu	Ni	Cr	Co
Bottom Head	A0063-2	0.23	1.29	Bal	0.016	0.22	0.15	0.58	-	-
Penetration Tube	NX4456	0.09	0.28	8.04	0.007	0.23	0.33	75.48	15.52	0.05
Penetration Tube	NX4416	0.08	0.31	7.99	0.007	0.21	0.32	75.48	15.58	0.05

Table 3: Semi-quantitative SEM-EDS Concentrations

Semi-quantitative SEM-EDS Concentrations (Wt. %)																		
Sample	C*	O	Mg	Al	Si*	S*	K	Ca	Ti	V	Cr*	Mn*	Fe*	Ni*	Cu*	Zn	Y	Mo
Figure 3. SEM and EDS Analysis – Sample #18 Area Scan 175 X.	36.09	27.39		2.57	4.50	0.15	0.14	0.40	0.58		0.23	0.10	3.14	0.74	0.42	23.54		
Figure 8. SEM and EDS Analysis – Sample #25 Area 1 Scan 50X.	22.21	58.68	0.05	1.48	4.12	0.08		0.28	6.09		0.05	0.11	4.52	0.30	0.12	1.91		
Figure 9. SEM and EDS Analysis – Sample #25 Area 2 Scan 50X.	16.02	61.19	0.28	2.67	5.31	0.09	0.02	0.46	10.44	0.12		0.03	1.61	0.04	0.05	1.66		
Figure 10. SEM and EDS Analysis – Sample #25 Area Fibers Scan 50X.	21.76	56.51		4.13	11.88	0.02	0.04	5.00	0.25		0.01		0.05		0.03	0.05	0.27	
Figure 14. SEM and EDS Analysis – Sample "under RXU2 #17 Boss" black side Area Scan 100 X.	53.87	37.51		0.27	5.80	0.20	0.06	0.31	0.14		0.03	0.02	1.40	0.07	0.04	0.24		0.05
Figure 17. SEM and EDS Analysis – Sample "under RXU2 #17 Boss" white side Area Scan 1 100 X	25.77	46.90	1.05	4.15	8.39	0.13	0.06	0.12	0.19		0.08	0.02	0.44	0.20	0.12	12.41		
Figure 18. SEM and EDS Analysis – Sample "under RXU2 #17 Boss" white side Area Scan 2 100 X	23.57	45.75	0.50	4.72	6.29	0.05	0.04	0.11	0.09		0.10	0.06	0.69	0.32	0.33	17.18		0.20

Elements in bold (C, O, Mg, Al, Si, S, K, Ca, Ti, Cr, Fe and Zn) are most likely from the materials used in packaging/shipping the reactor vessel head. The elements marked with an asterisk are present in the materials used to fabricate the bottom head and penetration tubes, with the exception of chromium. Chromium is not present in the bottom head.

Figures 5 and 6 show light microscopy images of both sides of particles obtained from the annuli of Penetrations 18 and 25. The distance between adjacent white lines at the bottom of each image is 1 millimeter. Under a microscope, the particles appear beige in color and flaky. The images of the particle taken from Penetration 25 clearly show the presence of thin fiber-like structures protruding from the bulk particle. SEM-EDS analysis of these fibers is shown in Figure 7. The X-ray map indicates the fibers contain significant amounts of aluminum, silicon, and calcium. All three elements are present in the glass yarn filaments used in polyethylene plastic filament reinforced tape.

In summary, the results of the follow-up analysis performed on samples obtained from Penetrations 18, 25, and the boss/vessel surfaces around Penetration 17, further support the conclusion that the residue observed in the annulus of some penetrations and on much of the reactor vessel surface is visually and chemically consistent with the materials used in the packaging and shipment of the reactor vessel.

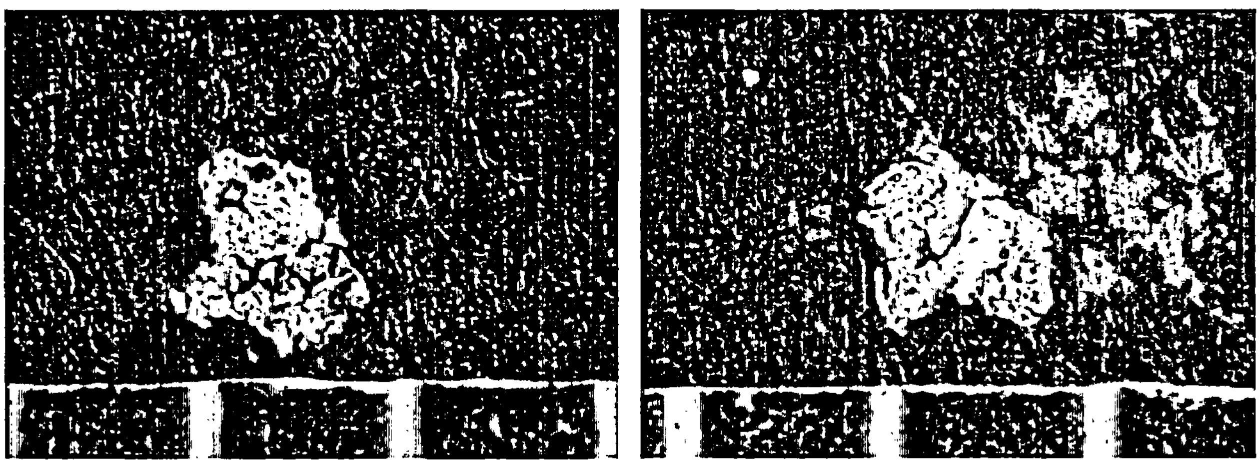
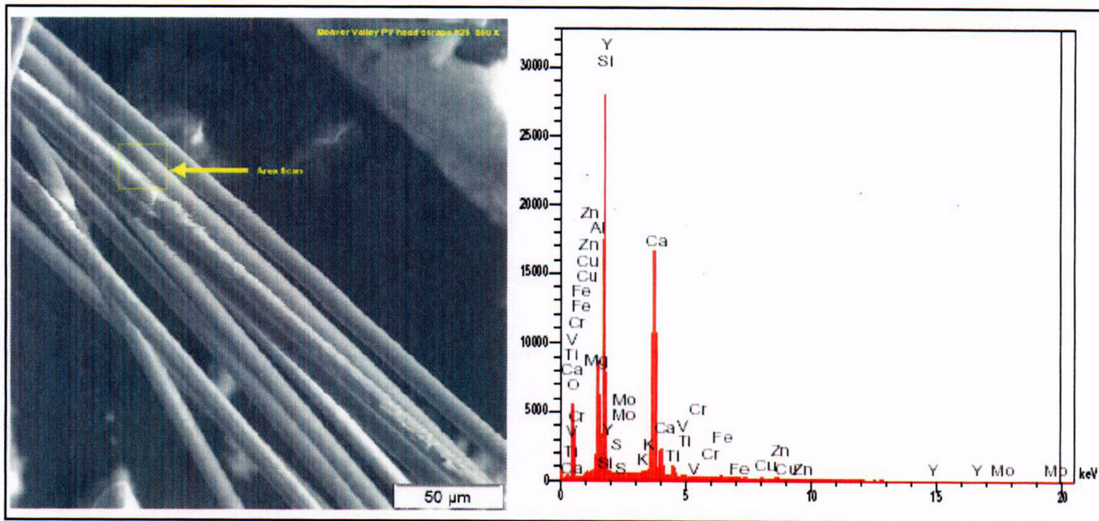


Figure 5: Light microscopy images of both sides of a particle scraped from the annulus of Penetration 18.

Figure 6: Light microscopy images of both sides of a particle scraped from the annulus of Penetration 25.



Elt	W%
C	21.76
O	56.51
Mg	0.00
Al	4.13
Si	11.88
S	0.02
K	0.04
Ca	5.00
Ti	0.25
Cr	0.01
Fe	0.05
Cu	0.03
Zn	0.05
Y	0.27

Figure 7: SEM-EDS analysis of fibers visible on particle scraped from the annulus of Penetration 25. Note the significant amounts Al, Si, and Ca present.

Packaging and Shipping History

In addition to the chemical analysis performed on the samples obtained from BVPS Unit 2, a review of the shipping and storage documentation related to the Unit 2 Reactor Vessel found additional information concerning the probable source of the residue. The entire "Reactor Vessel Packaging and Shipping Records Review" document, containing applicable specifications and procedures, was transmitted from Westinghouse to FENOC via Letter "Reactor Vessel Packaging and Shipping Records Review," October 3, 2003.

The supplier of the BVPS Unit 2 reactor vessel was Combustion Engineering (CE). A common proactive measure was to cover the reactor vessel lower head with protective Spraylat coatings for storage and shipping. Prior to the application of the Spraylat coatings, openings were to be covered with approved materials to prevent any of the Spraylat from coating the inside of the annulus. Such materials used include:

- Foil
- Pressed or waterproof fiber board
- Tape
- Herculite
- Cheese cloth

Of the five items listed above, the most likely candidates that could leave the type of residue observed during inspection include tape and cheese cloth. The residue has a texture similar to cloth materials, like cheese cloth or the backing of filament reinforced tapes (i.e. duct tape).

It was learned through discussions with personnel from the site where the vessel was fabricated that cheesecloth was first wrapped around the penetration tubing and then covered over with tape. Cheesecloth is a gauze material, primarily made of cotton fibers. Tape was then directly applied to the outer surface of the bottom of the vessel around the base of the penetrations.

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At the time of the Beaver Valley Unit 2 reactor vessel fabrication, three tapes were approved for packaging austenitic stainless steel and nickel base alloy components. They included:

- 3M "Scotch" Brand #481 Plastic (polyethylene) Tape
- 3M "Scotch" Brand #898 Filament Reinforced Tape
- Borden Chemical Co. Mystic Tape #5863

From the applicable procedure, the 3M #481 tape was noted as acceptable. This tape is a polyethylene blend with less than 0.10 weight percent halogens and sulfur as required by the AEC Regulatory Guide 1.38. Leachable chlorides were less than 5.0 ppm and leachable fluorides were less than 0.5 ppm. The total halogen plus sulfur content must be less than 1000 ppm.

An image of the Beaver Valley Unit 2 pressure vessel prior to installation is shown in Figure 8. Note the bright appearance from the Spraylat protective coating on the outer surface in the black and white photograph.

Figure 9 show a pressure vessel that had its original order cancelled. This vessel has remained stored outside at the Westinghouse Chattanooga site for over twenty years with the shipping materials still intact. Examples of this common storage practice around the head penetrations are shown in Figure 10.

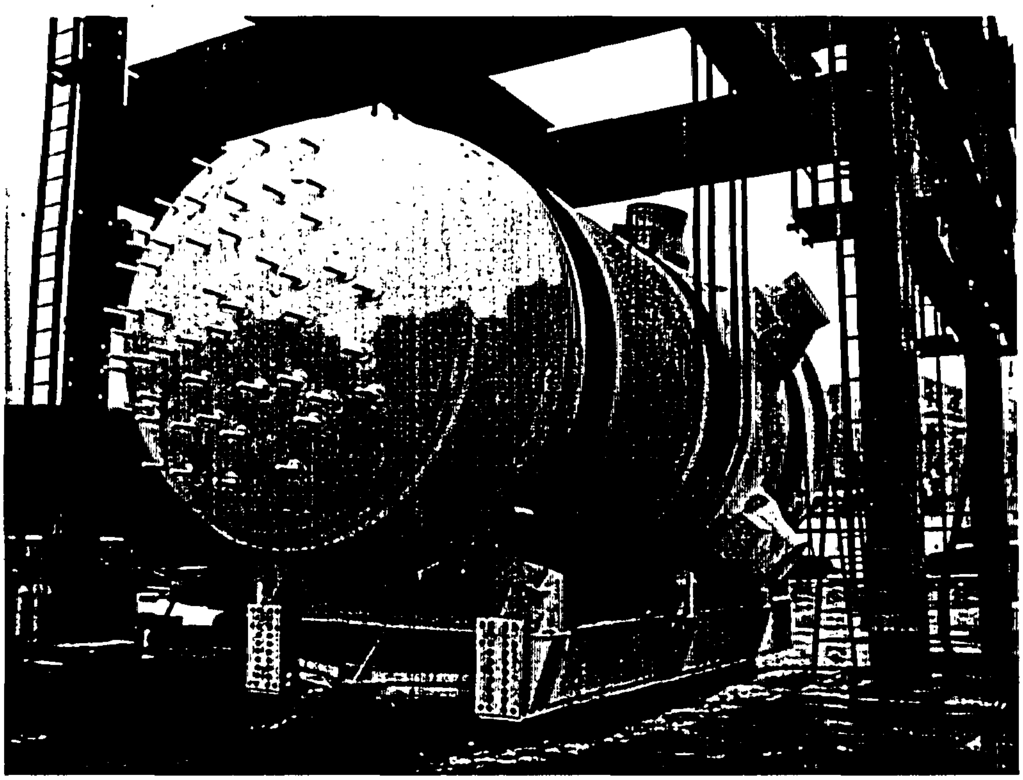

Figure 8: BVPS Unit 2 reactor vessel with Spraylat coating applied.

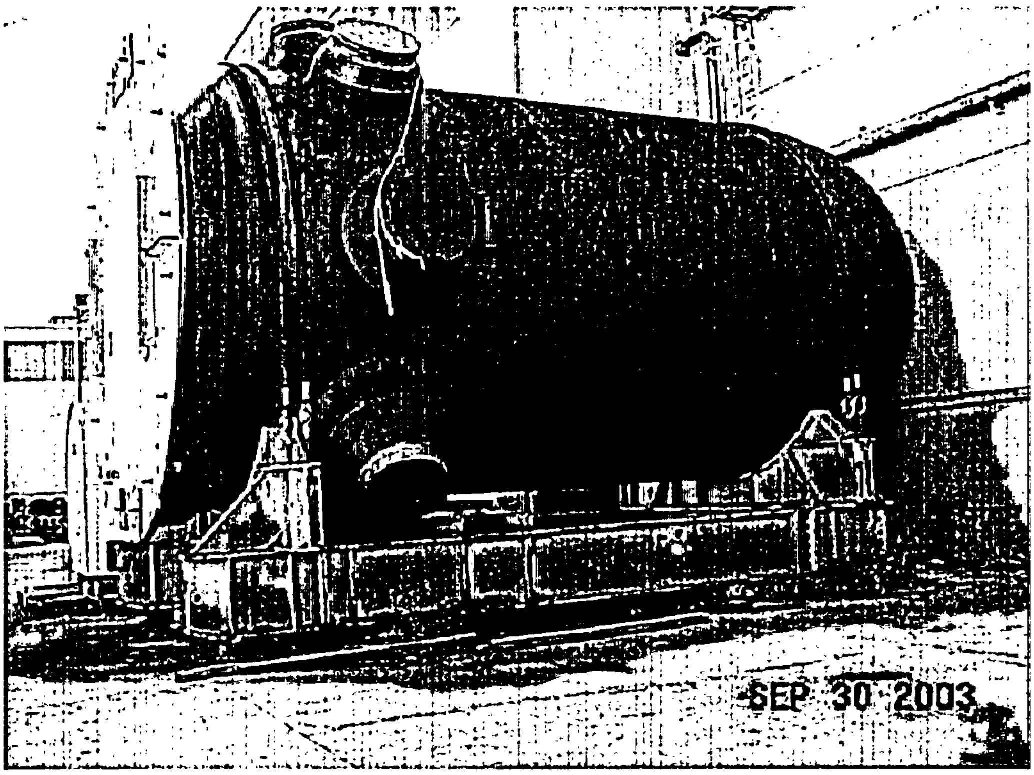

Figure 9: A Nuclear Reactor Pressure Vessel from a Cancelled Order (Note: This vessel has been stored outside at the Westinghouse-CE Chattanooga Site for over 20 years.)

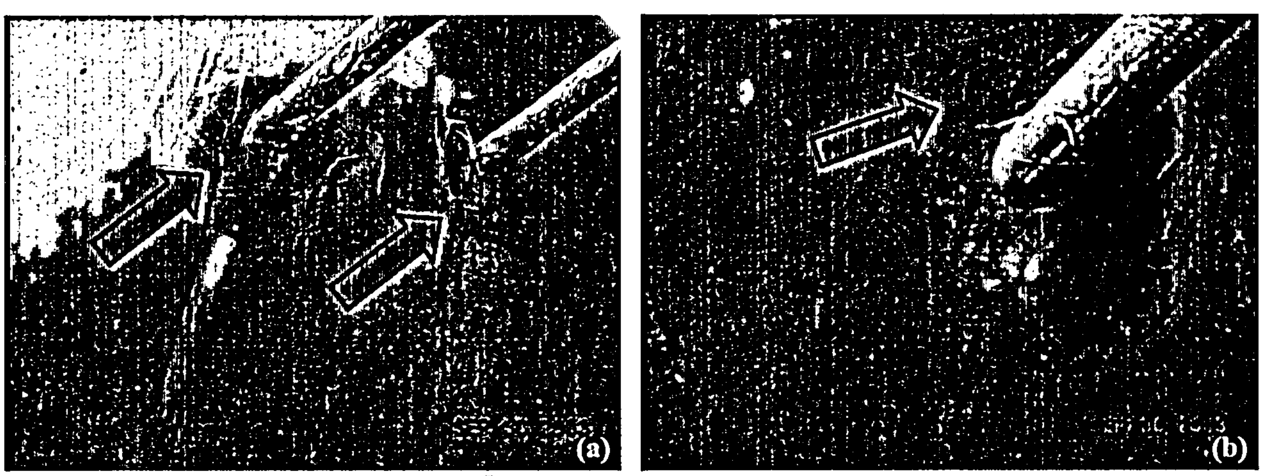

Figure 10: Examples of the Spraylat protective coating applied to the vessel (shown in Figure 9) surface (a) and the tape strips underneath the coating around each BMI penetration (b).

Industry Experience

Investigation of other issues in the industry regarding residue observed on the lower head found several experiences with a variety of issues, including Spraylat and Carboline paint. One vessel, in particular, exhibited similar residue on the lower head during a recent visual inspection. Further investigation of the construction records revealed packaging configurations very similar to those shown in Figure 10. This vessel was also manufactured by Combustion Engineering and is of similar vintage to the BVPS Unit 2 vessel. Figures 11 and 12 show the residue observed on the lower head and the packaging configuration of the BMI penetration tubes.

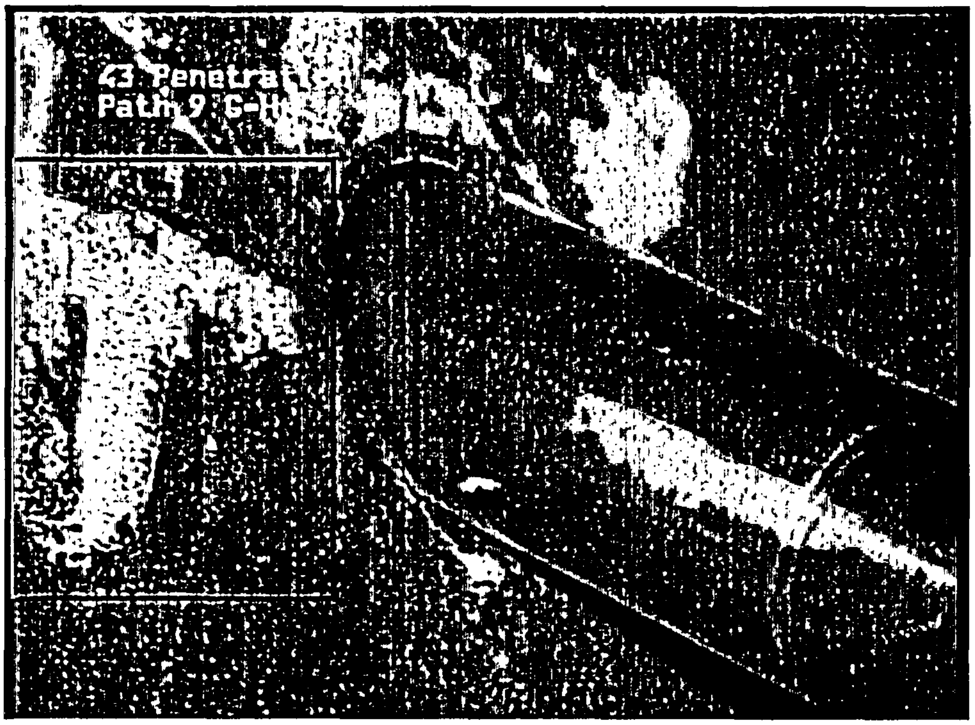

Figure 11: White residue, similar to that seen at BVPS Unit 2, observed during recent lower head inspection of another CE vessel of similar vintage.

Figure 12: Bottom head of another CE vessel of similar vintage to BVPS Unit 2 with packaging of the BMI penetrations intact.

Summary

The visual examination of the BVPS Unit 2 reactor vessel lower head during 2R10 identified no RCS leakage from any of the 50 BMI penetration tubes.

Residue was observed in or near the annulus between the reactor vessel and the penetration tube of 18 penetrations during the visual inspection. Similar residue was observed on the vessel surface around virtually every penetration. Initial samples of the residue from the annulus of one penetration and from the vessel surface were analyzed for the presence of boron and lithium and were found to contain less than 0.1ppm (the detection limit) of each.

Additional samples were obtained from the annuli of two more penetrations and the vessel surface around a third penetration. Elemental analysis of these samples was performed using SEM-EDS. The major elements present in all three cases were consistent with those found in the packaging materials used during shipment of the reactor vessel. Light microscopy and SEM images confirmed that the physical characteristics of the residue were flaky and fibrous, not the crystalline structure indicative of dried boric acid.

Review of construction and shipping records as well as industry experience with lower head inspections provided details of the procedures and materials used to package the reactor vessel prior to shipment. The composition of the materials used (reinforced tape, cheesecloth, etc.) is consistent with the elements present in the residue taken from the Unit 2 lower head.

The corroboration of the consistency of the visual appearance of the deposits, the supplemental chemical analysis results, and the historical and industry information regarding the packaging and shipping practices that were employed provide a sound explanation as to the origin of the residue. Furthermore, the documented visual inspection of the 50 BMI penetrations obtained during 2R10 will serve as an effective baseline for comparison to as-found conditions during the subsequent refueling outage.

Responses to NRC Teleconference Questions

NRC questions from 9/25/03 teleconference:

1. *Please discuss the* chemical *constituency of the "deposits" on the lower head and how it compares to your postulated cause of these deposits.*

   As discussed previously, and as shown in Tables 1 – 3, the major elements identified in the residue from the bottom of the reactor vessel are consistent with elements present in the materials used in the packaging and shipping of the reactor vessel and/or the materials used to fabricate the lower head and penetration tubes. Random trace elements identified in the analysis (V, Y, Mo) are likely the result of impurities present in the packaging materials.

2. *Please discuss* whether *any "deposits" were found on the surface of the insulation facing the head. Please discuss how these "deposits" would appear both in the annulus and on the tube if the root cause was it was paint or tape placed on the head during the fabrication.*

   In some locations, milky white streaking was observed on the surface of the insulation facing the head, presumed to be the result of previous reactor cavity seal leakage from above. The streaks were of no discernable thickness. The streaking observed is shown in Figure 13b.

   The previous discussion of the packaging and shipping process, including the images of similar vessels in the packaged configuration, supports the conclusion that the method in which the tape and cheesecloth was applied left behind a residue on the surface of the vessel, the penetration tubes, and the annulus.

3. *Please discuss why the* tape/*paint would be placed around some nozzles but not all.*

   There is evidence of residue on or around virtually every nozzle as shown in Figure 2. However, only 18 penetrations showed residue in or near the annulus and were thus called out for further evaluation during the visual exam.

4. *Discuss whether there are any photographs of the lower head since fabrication that would support your root cause.*

   Figure 8 shows the Unit 2 vessel with the Spraylat coating applied. Figures 10 and 12 show images of two other vessels in the packaged configuration, both fabricated by Combustion Engineering and of similar vintage. The method in which the vessel was packaged is clearly visible in each case.

5. *Please discuss your plans for* removing *these "deposits".*

   As was discussed on the follow-up telecon between FENOC and the NRC on 10/8/2003, the scope for the next Unit 2 Refueling Outage (2R11, Spring 2005) will include an as-found visual exam for comparison to 2R10 documentation, subsequently followed by a cleaning of the potentially interfering deposits from the area of interest to the extent practical, and an as-left baseline of the resulting conditions.

6. *It appears that there are some rust stains around some penetrations with no streaks leading into these areas (e.g., penetrations 39 and 42). Is this the case? If so, what is the cause?*

   The staining around a few of the penetrations is brownish red in color, and has no discernable thickness. There is no evidence of accumulated corrosion product on or around any of the penetrations, as would be the expected condition had primary water leakage caused corrosion of the carbon steel in the annulus between the penetration and vessel given the much greater volume of corrosion products compared to base metal.

   Given the methods used to package the vessel for storage, combined with the several years that the vessel remained in the packaged configuration and exposed to weather and temperature changes, it is likely that water/condensation developed in or entered the annulus of some penetrations. This would cause surface oxidation of the exposed carbon steel in the annulus, which was not protected by the protective Spraylat coating. It is reasonable to conclude that in some cases, depending on the condition of the tape/cheesecloth around each penetration, the wetted oxidation of the carbon steel within the annulus may have resulted in a brownish staining of the penetration and boss material near the area.

   Other conditions that could have caused such discoloration of the boss and penetration material include past inadvertent contamination by a carbon steel tool, transfer of carbon steel particles to the tape adhesive either when the tape was being applied or after it was removed, or other means.

7. *Penetration* 39, quadrant C appears to have streaking down the instrumentation tube. Is this the case (or is it an artifact of the lighting angle)?

   The streaking on Penetration 39 appears milky white in color, has no discernable thickness, and is not visually characteristic of penetration leakage (Figure 13a). Inspection of the vessel surface uphill of Penetration 39 shows streaking on the side of the vessel and insulation panels as well (Figure 13b), leading to the conclusion that previous reactor cavity seal leakage likely ran down the side of the vessel and onto the surface of Penetration 39, leaving a thin milky white stain.

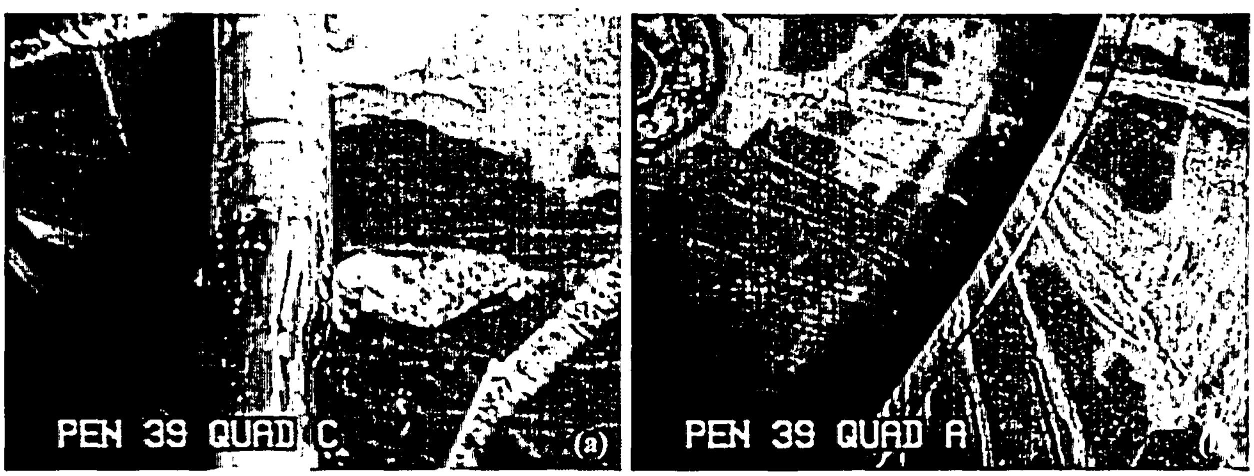

Figure 13: Streaking on Penetration 39 (a) and similar streaking on vessel surface and insulation uphill of Penetration 39 (b).

8. Please describe the characteristics of the white substance that was noticed on the 18 penetrations (40 quadrants) with regards to the following:

   a. *The density of the* white *substance and the location where the density is high.*

   The residue appears light and flaky. There is no particular location where the density appears higher than any other area. Most of the residue is located on the boss or vessel surface around each penetration.

   b. *We understand that Lithium was present in the substance. What is the source of the lithium?*

   Tests for lithium on the initial samples taken from Penetrations 29 and 43 were below the detectable limit, < 0.1ppm.

   c. *Is there any particular location of the penetration where the deposit is more predominant (i.e., the hill side of the vessel....). A picture depicting the BMI tubes and the locations of the deposits would be beneficial.*

   As shown in Figure 1 of this response, residue was observed in or near the annulus on the uphill, downhill, and sidehill orientations. The residue observed on the boss around many penetrations is randomly oriented in all directions. As shown in Figure 2, similar residue is observed on the vessel surface as well.

   d. *Were the chemical samples taken from the hill side of the penetration?*

   The samples were taken from the uphill side (29-A (boss), 17-A (boss)), downhill side (43-C, 25-B), and sidehill (18-D).

NRC questions from 10/8/03 teleconference:

1. *How many chemical samples were obtained and what locations were they obtained from? For example, were samples taken from both uphill and downhill sides of penetrations?*

   A total of five samples were obtained. The location and orientation of each sampled location is shown in the table in response to 10/8/03 Question #2.

2. *Discuss what chemical analyses were performed on each of these samples and what results were obtained? We understand that lithium was present in at least one sample. Please confirm this and discuss the source of the lithium.*

Sample	Approximate Orientation	Location	Analysis Performed By	Analysis Techniques
29-A	Uphill	Boss	BVPS	AA for Li ICP for B
43-C	Downhill	Annulus	BVPS	AA for Li ICP for B
25-B	Downhill	Annulus	Westinghouse	SEM-EDS
17-A	Uphill	Boss/Vessel	Westinghouse	SEM-EDS
18-D	Sidehill	Annulus	Westinghouse	SEM-EDS

AA = Atomic Absorption Spectrometer
ICP = Inductively Coupled Plasma Spectrometer
SEM-EDS = Scanning Electron Microscope – Energy Dispersive X-ray Diffraction

As discussed in further detail in the *"Follow-up Sampling and Analysis"* section of this response, the three follow-up samples were analyzed for chemical composition using Scanning Electron Microscope – Energy Dispersive X-ray Diffraction (SEM-EDS). As shown in Tables 1 – 3, the major elements identified in the residue from the bottom of the reactor vessel are consistent with elements present in the materials used in the packaging and shipping of the reactor vessel and/or the materials used to fabricate the lower head and penetration tubes. Random trace elements identified in the analysis (V, Y, Mo) are likely the result of impurities present in the packaging materials.

Lithium was not detected in the analysis performed on the follow-up samples. SEM-EDS lacks the ability to detect lithium and boron due to their low atomic numbers. However, the initial samples taken from Penetrations 29 and 43 were analyzed for lithium by BVPS using an Atomic Absorption Spectrometer (AA). The result of both analyses was <0.1ppm lithium, the detection limit for this analysis at BVPS. The samples from these penetrations were also sampled for boron using an Inductively Coupled Plasma Spectrometer (ICP). The result of both analyses was <0.1ppm boron, the detection limit for this analysis at BVPS.

3. *Discuss what you have learned about the tape/paint from review of original construction records. Were any previously taken photographs of the lower vessel head available?*

   Review of original construction records, procedures, and pictures has revealed that the application of tape and cheesecloth to the annulus area of the lower head penetrations was a common controlled practice to prevent the intrusion of the protective Spraylat coatings. This is discussed in further detail in the "Packaging and Shipping History" section of this response.

The only picture obtained of the BVPS Unit 2 lower vessel head is shown in Figure 8. Figures 10 and 12 show two CE-fabricated vessels of similar vintage in their packaged configuration. Since installation, the BVPS Unit 2 lower head insulation had not been removed until 2R10. Thus, no previous pictures of the residue exist.

4. *Discuss why the tape/paint appears to be around some penetrations and not others.*

The tape is consistently present on the boss and vessel surfaces around virtually all of the penetrations. However, the residue was not always present in the annulus. This is likely due to variability in the way in which the tape was applied and the environmental conditions to which each penetration was exposed to during storage (direct sunlight/shade, wet/dry, etc.).

5. *Discuss whether any statistical analysis of the chemical sampling results was performed to bound the statistical confidence that the deposits are all of the same origin.*

Sampling was performed as an engineering confirmation of assumptions, not for determination of statistical confidence. A statistical argument could not be developed due to the lack of relevant data. The combination of the visual consistency of the residue from penetration to penetration, the chemical results obtained on the five samples that were taken, and the historical and industry information that supports the postulated source of the residue provides a sound justification for the conclusion that all of the deposits are of the same origin.

6. *Discuss whether the annulus opening is visible and clearly unobstructed on all nozzles? If any annulus openings on any penetrations are not visible and clearly unobstructed, do you plan to clean the deposits from these location (not necessarily this outage, but next)? If not, do you plan on doing UT/EC at future outages?*

In many cases where residue was observed in or near the annulus area, the tube surface in the annulus above the residue is clearly visible. However, in some cases the residue in the annulus does not allow a clear view beyond it. This condition, due to the minuteness of the residue, would not in any way preclude the ability to detect leakage like that observed at STP-1.

See the answer to the 9/25/03 telecon, Q-5, for plans to clean the deposits from these locations.

7. *Discuss the conclusions you have drawn from the inspection and your basis for those conclusions.*

The visual inspection of the BVPS Unit 2 reactor vessel lower head during 2R10 identified no RCS leakage from any of the 50 BMI penetration tubes. This exam was capable of detecting small amounts of RCS leakage from the BMI penetrations like that observed at South Texas Project Unit 1. The documented results obtained during 2R10 will serve as an effective baseline for comparison to as-found condition during the subsequent refueling outage.

The corroboration of the consistency of the visual appearance of the deposits, the supplemental chemical analysis results, and the historical and industry information regarding the packaging and shipping practices that were employed, provides a sound explanation as to the origin of the residue. The supplemental analysis performed supports the conclusion that there is no indication of RCS leakage from any of the BMI penetrations and that the residue does not contain unacceptable levels of elements that could be deleterious to the vessel or penetration tubes.

8. *Discuss your plans to clean potentially interfering deposits from lower head penetrations at Beaver Valley Unit 1 during its next outage.*

The next scheduled refueling outage for BVPS Unit 1 is in the fall of 2004, at which time the lower head penetrations will be visually inspected. Should potentially interfering deposits be discovered during the visual inspection of the BVPS Unit 1 lower head penetrations, prudent measures will be taken to ensure the integrity of the RCS pressure boundary. These measures may include cleaning, boron/lithium analysis, chemical analysis, etc., depending on the nature of the deposits. Discoveries made requiring actions outside the scope of the planned evolutions may require additional planning, tooling, and personnel. Such evolutions may be postponed until the subsequent refueling outage to provide sufficient time to plan appropriate corrective actions that address the conditions that may be discovered as well as personnel safety and ALARA considerations.

ATTACHMENT 2

Commitment List

The following list identifies those actions committed to by FirstEnergy Nuclear Operating Company (FENOC) for Beaver Valley Power Station (BVPS) Unit No. 1 and No. 2 in this document. Any other actions discussed in the submittal represent intended or planned actions by Beaver Valley. These other actions are described only as information and are not regulatory commitments. Please notify Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement, at Beaver Valley on (724) 682-5284 of any questions regarding this document or associated regulatory commitments.

Commitment	Due Date
The scope for the next Unit 2 Refueling Outage (2R11, Spring 2005) will include an as-found visual exam for comparison to 2R10 documentation, subsequently followed by a cleaning of the potentially interfering deposits from the area of interest to the extent practical, and an as-left baseline of the resulting conditions. (CA 03-08900-11)	Completion of 2R11 (Spring 2005)
The next scheduled refueling outage for BVPS Unit 1 is in the fall of 2004, at which time the lower head penetrations will be visually inspected. Should potentially interfering deposits be discovered during the visual inspection of the BVPS Unit 1 lower head penetrations, prudent measures will be taken to ensure the integrity of the RCS pressure boundary. These measures may include cleaning, boron/lithium analysis, chemical analysis, etc., depending on the nature of the deposits. Discoveries made requiring actions outside the scope of the planned evolutions may require additional planning, tooling, and personnel. Such evolutions may be postponed until the subsequent refueling outage to provide sufficient time to plan appropriate corrective actions that address the conditions that may be discovered as well as personnel safety and ALARA considerations. (CA 03-08900-12)	Completion of 1R16 (Fall 2004) for the initial actions. (Follow-up actions may be postponed to the subsequent refueling outage as noted.)