From: "BENNETT, STEVE A" <SBENNE2@entergy.com>
To: "'Tom Alexion'" <twa@nrc.gov>
Date: 11/5/02 9:14PM
Subject: ANO-1 Draft Response to NRC Bulletin 2002-01

Tom,

Attached is the draft ANO-1 follow-up response to the Bulletin on the ICI nozzles. It has 3 files. The main response and two attachments. Let me know if you have any trouble opening them.

Steve Bennett

Mail Envelope Properties (3DC87877.138 : 14 : 37176)

Subject: ANO-1 Draft Response to NRC Bulletin 2002-01
Creation Date: 11/5/02 9:03PM
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Files	**Size**	**Date & Time**
MESSAGE	215	11/05/02 09:03PM
Draft NRCB 2002-01 RAI on ICI.pdf		48586
Attach 1 to ICI RAI.pdf	31435	
Attach 2 to ICI RAI	31157	
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Request for Additional Information Related to Bulletin 2002-01
Arkansas Nuclear One, Unit 1 (ANO-1)

1. Provide detailed drawings and dimensions of the vessel bottom (including the vessel skirt, insulation, etc.) showing the instrumentation nozzles; include on these drawings the boric acid deposits (e.g. staining) based on information obtained from your video tapes. Show the nozzles in the vicinity of nozzle 30 down to nozzle 1 and in the vicinity of nozzle 15 down to nozzle 1.

Response:

Attachment 1 (Diagrams of penetrations through vessel skirt, nozzle layout, and description) identifies the nozzles that were inspected using a boroscope and the results. The four nozzles inspected by a boroscope were the only incore tubes that had staining below the insulation. The purpose of the boroscope inspection was to determine whether these nozzles had any evidence of leakage at the vessel interface. Attachment 2 provides a scale composite drawing showing the dimensions of the reactor vessel, support skirt, insulation details, and nozzle 1 and 30.

The attachments are included as separate documents.

2. Explain your best efforts to locate the source of the boric acid deposits. Address the feasibility of performing additional inspections of the annulus between the vessel/support skirt and the vertical insulation or from the under vessel area to provide further evidence of the path of borated water through the 2 inch support skirt openings.

Response:

The purpose of the inspection was to determine if there was any evidence of incore instrument nozzle leakage. The initial inspection of the under vessel area was a 360 degree visual inspection of each incore tube in the area where it penetrated the insulation under the vessel. There is a small annulus between the insulation and the tubing. Since the tubing runs vertically directly to the vessel and the distance between the vessel and the insulation varies from approximately 2 to 18 inches, leakage of an incore nozzle would be evident by boric acid deposits at the area where the tubing penetrates the insulation. There were two conditions noted during this inspection. 1) Four incore tubes had white staining on them below the insulation. 2) There was staining on the concrete pedestal walls, staining on some insulation seams and staining with some small boric acid deposits on the floor. None of the staining was moist or appeared to be from active leaks.

A condition report was initiated documenting the traces of boron found on the ANO-1 incore instrument tubes and the boric acid staining in the general area.

To ascertain the source of the staining on the four incore tubes, the insulation collars around each tube were removed and a boroscope inspection of the tubing above the insulation up to and including the nozzle to vessel interface was performed. The inspection revealed that the staining was not originating from the nozzle at the vessel interface or from the tubing. There were faint stains indicating fluid had dripped down the bottom curvature of the vessel. These traces appeared to initiate above the uppermost circle of tubes and was clearly not generated from the incore nozzles.

A search of historical records, previous photographs of the area and interviews of personnel who had previously performed VT2 inspections was conducted. It was determined from that review that the conditions in the undervessel area had been essentially the same for several years and there was no evidence of a change in the appearance of the area this outage.

Based on discussions with site personnel (refueling team, operations, maintenance staff) that were familiar with past activities and issues in the reactor vessel area, instances of cavity seal plate leakage were identified as likely sources for the staining identified in the general area under the vessel. In order to understand the relationship of the vessel, the insulation, the concrete structure, and the drainage path for cavity seal plate leakage, the composite drawing previously identified was developed for this area. Additionally, it was determined that decontamination efforts of the transfer canal near the vessel flange area during the 1980's and early 1990's included rinsing fluid into the cavity seal plate area when the plate was not installed. During this time frame, cavity seal plate leakage was a fairly common occurrence as well as CRDM flange and RVLMS flange leakage decontamination efforts with the cavity seal plate removed. Also an overflow of the incore tank (R-8) that occurred in September 1999 was identified as a source for some of the boron residue identified on the floor in the area under the reactor vessel. Based on these reviews, probable flow paths have been identified that correspond to the indications seen. Documented inspections of the area under the vessel from the previous two outages to the present do not indicate any change in condition to this area.

The reactor cavity seal plate leakage would traverse the annulus area between the vessel and the mirror insulation to reach the undervessel area. The ability to perform additional inspections of the vertical annulus area between the vessel and the mirror insulation has been evaluated. To provide direct visual evidence of the path of borated water through the 2 inch holes in the support skirt above the undervessel insulation, access to the annulus would have to be gained. Possible access routes to inspect the area are limited to access from the top of the reactor vessel and access from below the vessel. There are no access locations between the top and bottom of the vessel because of the primary shield wall. The only openings through the shield wall are around the reactor vessel nozzles and these are too tight a fit to permit access. Access from the top of the vessel to the annulus between the shield wall and the reactor vessel is restricted by the reactor shield blocks. They consist of concrete filled, steel lined blocks. The shield blocks are located below the permanent seal ring at the top of the vessel and above the reactor vessel nozzles. These shield blocks provide a radiation shield in the annulus between the top of the reactor vessel and the floor of the refueling canal. There is no access through these blocks without removing them from above. This can only be accomplished by removing portions of the permanent seal plate.

The only other access to the area between the vessel skirt and the vessel insulation is from the bottom of the vessel. Access of this area is difficult to accomplish. One horizontal insulation panel in proximity to nozzle 30 could be removed to gain access to the area below the holes and a boroscope inserted through the area between the two adjacent incore nozzles, up to the accessible two (2) inch diameter holes located around the circumference of the skirt. Once through the hole, a limited local area between the skirt and insulation could be viewed.

Given the minimal information to be gained, coupled with the clear evidence that the boric acid traces originated above the ICI nozzles, it is our conclusion that further inspection activities are not warranted.

3. Characterize the boric acid deposits.

4. Describe what you see in the space between the vessel base metal and the outside diameter of the instrumentation nozzles.

Response (3 and 4):

See Table Below

1R17 Under-Vessel Inspection

Summary of Observations

Boron or Stain Location	General Description / Characterization	Probable Source	Leakage Path for Probable Source	Supporting Evidence
Walls of Reactor Pedestal	Generally straight streaks that originate from out of sight at the top of the wall and extend to the floor. They appear to be the residue from liquid that has flowed down the walls of the cavity from above. The streaks exhibit fairly uniform radial spacing.	Seal plate leakage.	Past the ID or OD of the seal plate, down the sides of the vessel either inside or outside of the vertical insulation panel, through the lower 9.25" or 2" holes in the vessel support skirt, and down the walls of the cavity.	History of seal plate leakage. By the design the holes in the vessel skirt and the cavity walls themselves represent the only drain path from the annulus around the vessel. Walls would be shielded from ICI nozzle leakage by the bottom head insulation panels.
Floor of Reactor Cavity	Similar to the indications on the cavity walls. Flow paths meandered to the low point of the floor instead of forming straight streaks.	Seal plate leakage. A natural continuation of the indications seen on the walls.	See discussion above.	See discussion above. The minor indications seen on the 4 ICI tubes would not account for the degree of staining observed on the cavity floor.
ICI Tubing Near the Incore Tunnel / Tubing Support	White drips and runs starting at points on the tubing near the floor and tunnel opening.	Drips from seal plate leakage coming off the wall above the incore tunnel.	See discussion above.	None of these indications originate from points near the bottom head insulation panels.
Nozzle 1	Faint white staining is visible on the nozzle piping extending from the vessel down through the insulation to below the insulation. The stain ranges in width from ¼ to ½ the circumference of the nozzle pipe. Some barely noticeable brown staining is visible on the nozzle piping (approximately 1 pencil width wide. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus between the	The faint indications suggest small amounts of moisture from seal plate leakage or decon activities.	Past the ID or OD of the seal plate, down the side of the vessel inside the vertical insulation panel, through the upper 2" holes in the vessel support skirt, splashing onto the underside of the vessel or onto the top of the bottom head insulation panel.	No indications of flows or traces from adjacent nozzles.

	nozzle and the lower vessel wall.			
Nozzle 7	Two very small, very thin, brown traces extend down the nozzle pipe, one approximately 2" to 3" long. The other trace extends approximately ½" down the pipe. The traces are ½" apart. Numerous small individual stain spots are visible on one side of the nozzle piping, approximately 120 degrees around from the brown traces. These spots appear to be dried residue from moisture droplets. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus between the nozzle and the lower vessel wall.	See above.	See above.	See above.
Nozzle 15	A single faint white stain can be seen on the nozzle piping just below the vessel, extending down below the insulation. The stain appears to be approximately a pencil width wide. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus between the nozzle and the lower vessel wall.	See above.	See above.	See above.
Nozzle 30	Two thin, faint white traces appear uphill. The source is out of sight of the boroscope on the vessel. The traces run to and down Nozzle 30. The traces appear less than a pencil width	Seal plate leakage that splashed onto the bottom of the vessel.	Past the ID or OD of the seal plate, down the side of the vessel inside the vertical insulation panel, through the upper 2" holes in the vessel support skirt, splashing onto the underside of	Nozzle 30 is on the outer edge of the ICI nozzle pattern, which means there are no other nozzles located uphill of Nozzle 30 that could have acted as a source for these traces.

	wide and are approximately 1 inch to 1.5 inches apart. Faint white staining of the nozzle piping is visible (approximately one to two pencil widths wide). These traces appeared to be residue left over from a past occurrence when fluid may have gotten on and ran down the side of the vessel. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus between the nozzle and the lower vessel wall.		the vessel, and down the underside of the vessel to Nozzle 30.	
Bottom head insulation panel lap straps	Faint white residue along the edges of some insulation panel lap straps (joint cover strips).	Seal plate leakage that has run onto the top of the insulation panel.	Past the ID or OD of the seal plate, down the side of the vessel inside the vertical insulation panel, through the upper 2" holes in the vessel support skirt, onto the top of the bottom head insulation panel, and down between the joints of the insulation panels.	History of seal plate leakage.

5. Provide the Owners Group's susceptibility report for the instrumentation nozzles and welds, as installed.

Response:

B&W Owners Group Report 51-5001951-01, *Alloy 600 PWSCC Susceptibility Model* dated December 16, 1998 was developed by the BWOG members to provide a relative ranking for potential failure of Alloy 600 components to PWSCC. This report is proprietary to the Owners and cannot be released without each of their authorizations. This cannot be accomplished in the time frame for response to this RAI. However, the following is a summary of the model development and the relative ranking of the ANO-1 nozzles, including the ICI nozzles, for NRC consideration.

The three primary considerations that went into the model development was:

- the susceptibility of the A600 materials including chemical composition, heat treatment, material microstructure and general operating parameters,
- stress factors including residual stresses (surface effects, weld geometry and stress relief) and operating stresses, and
- the PWR primary water environment of the material including temperature, hydrogen, boron content, and sulfur intrusions

The susceptibility model used the CIRSE crack initiation approach used for the CRDM nozzle PWSCC susceptibility predictions. In addition, a statistical process was applied using the Monte Carlo Method for allowing input parameters to have distributed values. As a result, susceptibility factors, stress factors, and environmental factors were built into the model based on information acquired from fabrication and plant operations. Relative susceptibility rankings were then established to result in predicted 10% cracking for each of the Alloy 600 components.

For ANO-1 the following provides the results relative time to failure (RTTF) of the ICI nozzles to other ANO-1 susceptible components:

Component	RTTF	Rank
Pressurizer replacement level tap nozzle	.061	1
Pressurizer thermowell nozzle in lower sensing line	.070	2
Pressurizer vent nozzle	1.99	4
RCS Hot Leg Pressure tap nozzle	4.63	8
CRDM nozzles	4.78 – 23.13	9
Instrument penetration (ICI nozzles)	95.96	35
Modified instrument penetration (ICI nozzles)*	532.28	47
Total components ranked	---	54

*- The ANO-1 ICI nozzles have been modified. The nozzle piece yield strength and weld design differ from the original nozzle material resulting in differences in susceptibility.

6. Describe the previous boric acid overfill events and corrective actions taken in response to these events.

Response:

Cavity seal leakage events prior to installation of the permanent canal seal plate were not consistently documented in condition reports. Thus, documentation of the number of these occurrences and the leak rates is not readily available. Canal seal plate leakage events can be inferred from a review of the history of ANO-1 Procedure OP-1504.005, Canal Seal Plate Installation. That history, indicates that the procedure was revised three times to address torquing of the seal plate nuts, three times to address use of RTV and once to address the thickness of the seal gasket. All revisions were made to address continuing leakage concerns. To understand the extent of the leakage, an internal memorandum dated January 8, 1985, indicates that after re-torquing the nuts in a previous outage, the leakage was reduced to 0.8 gpm. On the high side, discussions with a former ANO-1 Operations Manager indicates that it was not uncommon to have initial seal plate leak rates of 15-20 gpm. When this type leakage occurred, it would result in lowering of the canal water level to re-torque bolts or add RTV to reduce the leak rate to an acceptable level. A permanent seal plate was installed in 1993 to provide a permanent fix to the concern. There has not been a history of leakage concerns since that time.

7. Explain how identification of these boric acid deposits and any corrective actions comport with your boric acid control program and the ASME Code requirements. Discuss any program or procedure changers you plan to undertake as a result of this experience.

Response:

Inspection for boric acid deposits under the Unit 1 Reactor Vessel is currently documented in procedure 2311.009 "ANO Unit 1 and Unit 2 Alloy 600 Inspection". This procedure was revised prior to 1R17 to enhance undervessel inspections. It was determined that more thorough examinations than the previous VT-2 inspections were warranted for 1R17. Form 1 of this procedure contains a sign-off for a "Lower Rx Vessel Head" inspection. This procedure states "This inspection is intended to perform an effective 360 degree inspection of the incore nozzles from below the insulation and report any sign of boric acid or discoloration. For nozzles with indications, inspect the nozzle to head interface for signs of leakage."

The ASME code inspection (VT-2) is controlled by procedure 5120.243 "Unit 1 Post Outage Pressure Test." The inspection of the RCS pressure boundary is performed by and documented in this procedure. These inspections are performed by qualified VT-2 inspectors when the plant is at normal operating pressure and temperature greater than 500 degrees F. Attachment 1, section 1.E of the procedure calls for an inspection of the "Instrument Nozzles" (Observe under vessel).

It is expected that the procedure 2311.009 "ANO Unit 1 and Unit2 Alloy 600 Inspection" will be reviewed to: 1) Make the 360° visual inspection of the ICI nozzles apply to future ANO-1 refueling outages and to include requirements to do a bare metal visual inspection of any tube that has boric acid traces detected below the insulation. 2) Evaluate the procedure to ensure adequate inspections of Unit 2 I-600 nozzles are included in the procedure based on lessons learned. A condition report action item has been issued to track the procedure change and evaluation (CR-ANO-1-2002-1233, Corrective Action #3)

8. Summarize recommendations received from Framatome for the inspection of the incore instrumentation nozzles and your disposition of these recommendations, and provide the basis for any recommendation not followed.

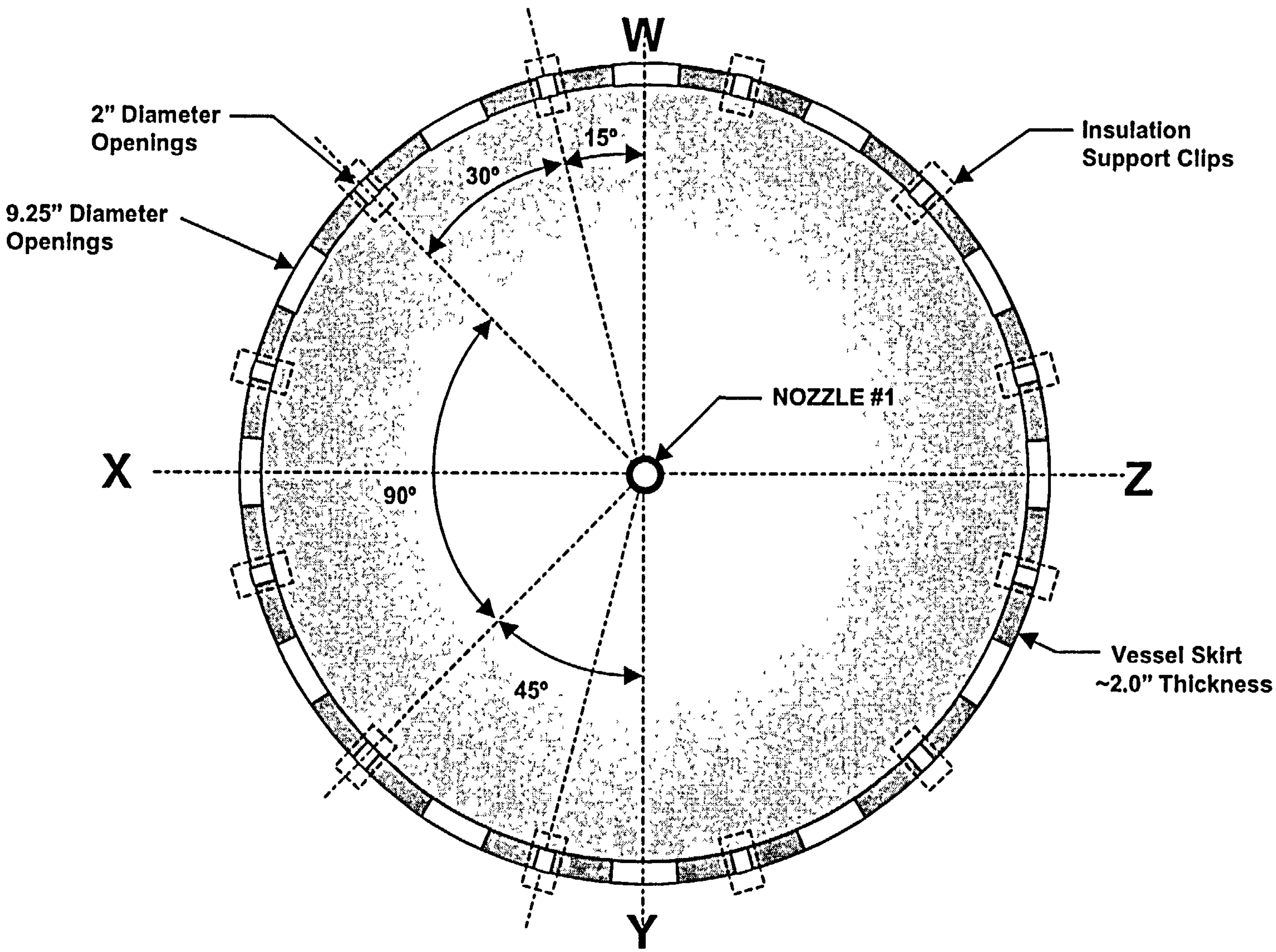
Response:

ANO has received documentation from Framatome ANP which includes the following statements of recommendation, "Under ideal circumstances, NDE (UT/ECT/PT) would be the suggested corrective action. However, given the current state of qualified NDE techniques and accessibility concerns, a bare metal visual examination of the IMI nozzle/lower RV head interface area at all B&W – fabricated 177-FA reactor vessels should be performed at the earliest opportunity. Other actions may also be appropriate to consider." (from Preliminary Report of Safety Concerns); and "For this reason, Framatome ANP recommended that a visual inspection of the IMI nozzles at ANO-1 and ONS-2 be conducted during the current refueling outages. A visual inspection for this purpose would, ideally, be a bare metal examination of all 52 IMI nozzles and the lower reactor vessel head." (Framatome ANP letter to W.R. Campbell, Entergy Operations, Inc.).

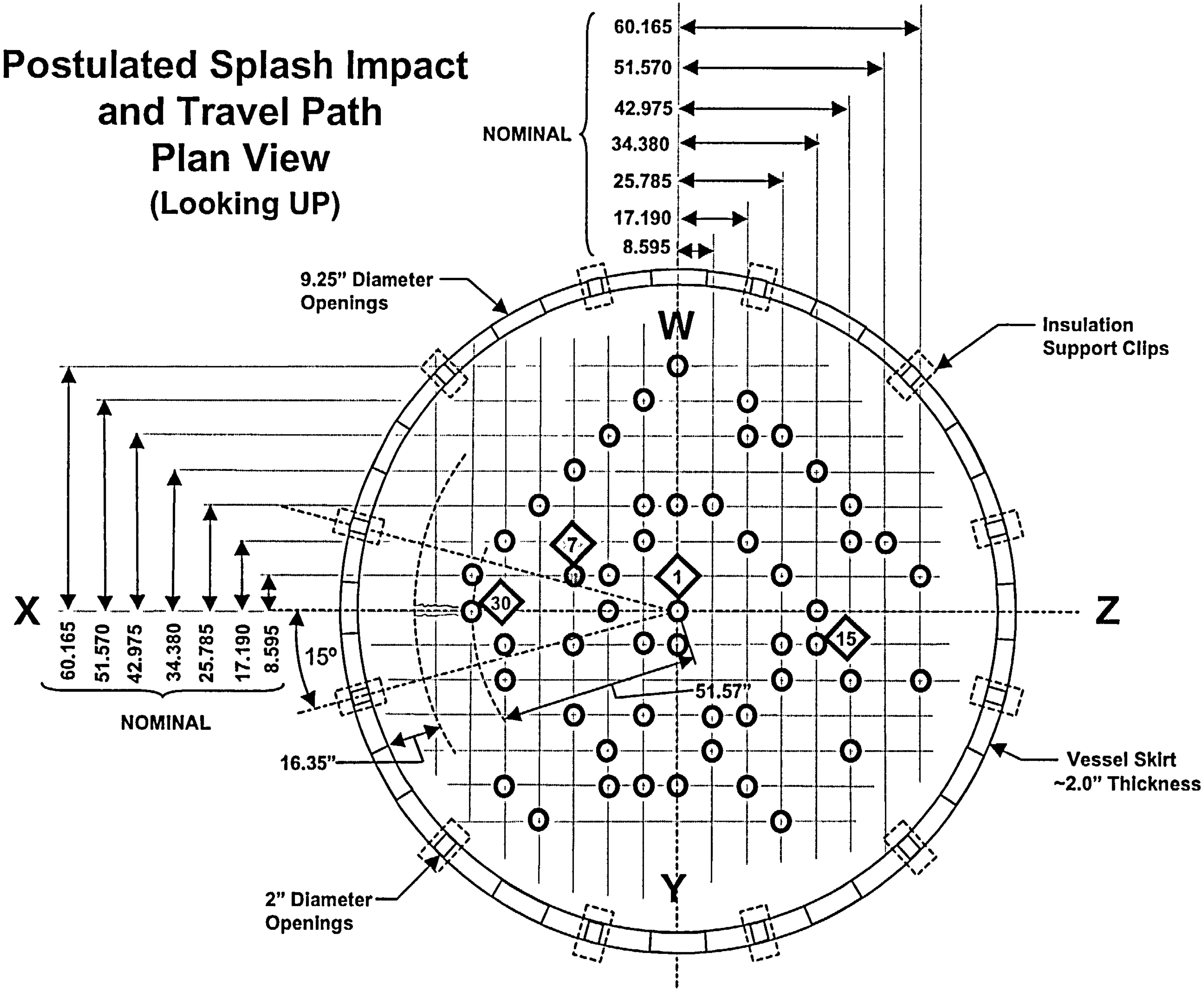
However, in further discussion with Framatome the above recommendations were made with the concern of not being able to identify leakage below the insulation. The recommendations were also based on the configuration of the insulation package at a plant that has a different design than ANO. Entergy believes that the insulation design at ANO-1 allows an easier flow path for boric acid leakage to be visibly revealed from below the insulation. Therefore, boric acid leakage would be more readily manifested below the insulation and would have a higher potential to be identified from our inspections. It is recognized that the Framatome recommendation to perform a complete bare metal visual inspection provides some higher level confidence of early detection. In light of information received by Entergy to date we believe that the inspection conducted by ANO-1 is adequate to detect boric acid indicative of a leak. Entergy intends to work with Framatome and the other Owners to better understand needed inspection techniques and potential repair options.

To determine the most appropriate inspection, the relative susceptibility, projected dose and the ability to individually inspect the vessel/nozzle interface of nozzles indicating evidence of boric acid were considered. Based on these considerations the most appropriate inspection was determined to be a thorough (360 degree) inspection of all nozzles below the insulation, with specific follow up inspections of the vessel/nozzle interface for nozzles indicating evidence of boric acid. From the geometry of the incore tubing and insulation, there is a high probability leakage would be evident below the insulation. A video inspection that focused on identifying any indications of borated water leakage has been performed. This inspection consisted of thorough visual inspection of the bottom of the reactor vessel insulation and ICI nozzles looking for any signs of boron crystals or staining on the nozzles. Based on this inspection, four nozzles (#1, #7, #15, and #30, see attached diagram) were identified as having evidence of a substance on the nozzle pipe. These indications resulted in additional inspections at nozzles #1, #7, #15, and #30 using a boroscope to look at the areas where the nozzles penetrate the reactor vessel as well as the reactor vessel surface immediately adjacent to the nozzles. These examinations did not identify any signs of leakage from the nozzles and indicated the sensitivity of a below the insulation inspection to identify small traces of fluid leakage from above. Based on the geometry of the nozzle configurations and the precedence of other RCS leaks resulting in easily identifiable indications of leakage, no other inspections are deemed necessary. The lack of boron evidence on any of the other nozzles below the insulation gives a high degree of confidence that no leaks are present.

Reactor Vessel Skirt Openings and Locations
Plan View – Looking UP



Postulated Splash Impact and Travel Path Plan View
(Looking UP)



Boroscopic Inspections of ICI Nozzles

The annuli between Nozzles 1 and 30 and the Rx vessel were inspected with a boroscope on 10/7/02, and the annuli of Nozzles 7 and 15 were inspected on 10/8/02.

In general, the vessel itself was noted to be relatively clean and in good condition, with uniform brown spotted discoloration of the silver-colored, high-temperature coating. The conditions noted were characterized as normal considering the age of the vessel. No "popcorn" type boric acid deposits or other typical boric acid accumulations were seen at or near the nozzles inspected. The condition noted during the inspection was generally faint white staining of the nozzle piping. Some light brown staining was observed on two nozzles but this is attributed to moisture external to the vessel. Limited boroscope video of the top side of the vessel insulation was obtained in the areas of nozzle # 15 and # 7. This video showed no staining or accumulation of boron on the insulation. The angle iron support structure for the insulation was very clean, with a few small widely spaced surface corrosion areas noted.

30

Two thin, faint white traces appear uphill, out of sight of the boroscope on the vessel and run to and down Nozzle 30. The traces appear less than a pencil width wide and are approximately 1 inch to 1.5 inches apart. Faint white staining of the nozzle piping is visible (approximately one to two pencil widths wide). These traces did not appear to be "active" sources, but rather appeared to be residue left over from a past occurrence when fluid may have gotten on and ran down the side of the vessel. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus.

Boroscopic Inspections of ICI Nozzles

15

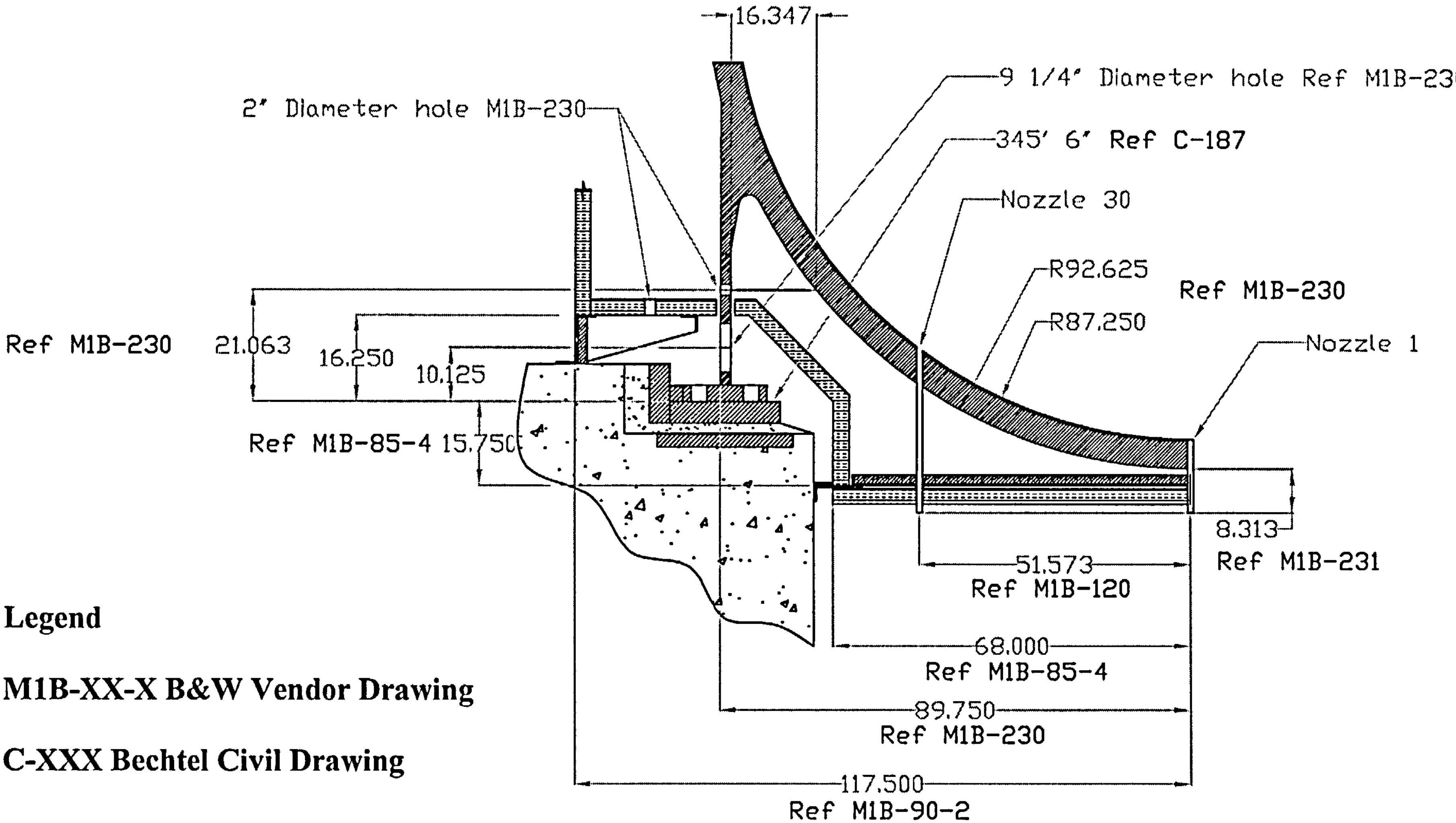
A single faint white stain can be seen of the nozzle piping just below the vessel, extending down below the insulation. The stain appears to be approximately a pencil width wide. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus.

7

Two very small, very thin, brown traces extend down the nozzle pipe, one approximately 2" to 3" long. The other trace extends approximately ½" down the pipe. The traces are ½" apart. Numerous small individual stain spots are visible on one side of the nozzle piping, approximately 120 degrees around from the brown traces. These spots appear to be dried residue from moisture droplets. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus.

1

Faint white staining is visible on the nozzle piping extending from the vessel down through the insulation to below the insulation. The stain ranges in width from ¼ to ½ the circumference of the nozzle pipe. Some barely noticeable brown staining is visible on the nozzle piping (approximately 1 pencil width wide. A 360-degree close-up inspection of the nozzle shows no indication of boron originating from the annulus.



Legend

M1B-XX-X B&W Vendor Drawing

C-XXX Bechtel Civil Drawing