FirstEnergy

Davis-Besse Nuclear Power Station
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United States Nuclear Regulatory Commission
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Washington, D. C. 20555-0001

Subject: Davis-Besse Nuclear Power Station Incore Monitoring Instrumentation Nozzle Inspections

Ladies and Gentlemen:

This letter responds to an NRC request for a summary of the inspection findings, conclusions, and plans regarding the Davis-Besse Nuclear Power Station Unit 1 (DBNPS) Incore Monitoring Instrumentation (IMI) nozzles. During the DBNPS Thirteenth Refueling Outage in Spring 2002, a visual inspection was performed of the Reactor Vessel (RV) beneath the flange level. This inspection identified stains consisting of boric acid residue and rust/corrosion running down the external RV sides and the bottom. A video inspection of the RV underside was completed in June 2002. This video inspection showed a number of the IMI nozzles having stains around the nozzle penetrations. The majority of nozzles with stains were directly in the flowpaths. The stained deposits around the nozzle penetrations were flat and tightly adhering to the RV surface. No indication of 'popcorn-type' boric acid deposits was observed around the nozzle penetrations. No wastage on the RV underside was found, and no buildup of boric acid or corrosion products was found on top of the RV underside insulation panels. The video taken during the inspection is currently available on site for NRC review.

In an effort to determine the source of these deposits, FirstEnergy Nuclear Operating Company (FENOC) staff obtained samples of the deposits for chemical analysis. In addition, FENOC sponsored laboratory simulation tests of IMI nozzle reactor coolant leakage to determine IMI nozzle leakage deposit characteristics. This chemical analysis and leakage testing was performed to aid in determining the source of these deposits, their significance, and the capability for early visual detection of IMI nozzle leakage.

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As a result of the aforementioned inspections, sampling, chemical analysis, and testing, the FENOC staff has concluded these deposits on the RV underside resulted from boric acid residue and corrosion products washed down from the RV upper head and from past refueling canal leakage. As demonstrated by the IMI nozzle leakage simulation testing and the recent experience at the South Texas Project Electric Generating Station, visible evidence, in terms of built-up boron deposits (as opposed to the as-found tightly adhered stained deposits), would be expected to be present on an IMI nozzle even for very small leaks.

Following the completion of the inspections and sampling, the RV underside was cleaned. During the recent temporary pressurization of the Reactor Coolant System, including the RV, to 250 psig, all IMI nozzle penetrations were visually inspected for leakage. No leakage indication was identified from the IMI nozzle penetrations.

As part of the restart activities, the Reactor Coolant System, including the RV, will be temporarily pressurized to approximately normal operating pressure (~2155 psig) and held for approximately seven days. The IMI nozzle penetrations will be visually inspected following this test with a crawler video camera to confirm there is no leakage from the IMI nozzle penetrations. The inspection will consist of a complete 360 degree examination of each IMI nozzle penetration.

In accordance with the commitments contained in its March 31, 2003, letter Serial Number 2833, response to NRC Bulletin 2001-01, FENOC will perform similar inspections of the RV underside IMI nozzles each refueling outage. In addition, as previously discussed with the NRC staff, FENOC will perform this inspection during the upcoming Cycle 14 mid-cycle outage.

As a further means of detecting leakage, FENOC is installing a FLUS on-line leak monitoring system under the RV. This on-line leakage detection system would assist in the early detection if any appreciable leakage were to occur from an IMI nozzle.

During the past year, the FENOC staff has discussed the above information with the NRC staff at several Inspection Manual Chapter 0350 Panel meetings and two public meetings held at NRC Headquarters. In particular, the November 26, 2002, and April 4, 2003, meetings focused on the IMI nozzle inspections, sampling and chemical analysis, and testing.

In conclusion, the inspections, analyses and testing that have been performed provide reasonable assurance that the rust/corrosion stains and boric acid residue found around several IMI nozzle penetrations during the initial visual inspection did not result from leakage from the IMI nozzles. This conclusion will be confirmed during the inspection following the seven day test at normal operating pressure.

Additional detail is provided in Attachment 1 to this letter. Should you have any questions or require further information please contact Mr. Kevin L. Ostrowski, Manager – Regulatory Affairs, at (419) 321-8450.

Very truly yours,

Mark B. Bezilla
Vice President – Nuclear

MSH/CAH/

Attachments

cc: Regional Administrator, NRC Region III
J. B. Hopkins, DB-1 Senior NRC/NRR Project Manager
C. S. Thomas, DB-1 NRC Senior Resident Inspector
Utility Radiological Safety Board

SUMMARY OF INCORE MONITORING INSTRUMENTATION (IMI) NOZZLE INSPECTIONS AND RELATED ACTIVITIES DURING THE DAVIS-BESSE NUCLEAR POWER STATION THIRTEENTH REFUELING OUTAGE

Background

Davis-Besse Nuclear Power Station Unit Number 1 (DBNPS) utilizes a Babcock and Wilcox type reactor. There are 52 IMI guide tubes (nozzles) that penetrate the bottom of the Reactor Vessel. These nozzles are fabricated from Alloy 600 material, are approximately one inch outside diameter, and are attached at the inside surface of the Reactor Vessel with a J-Groove weld. A five to ten mil diametrical gap (annulus) exists between the tube and the carbon steel Reactor Vessel below the J-Groove weld.

The bottom of the DBNPS Reactor Vessel operates at a lower temperature (i.e., approximately 558°F) than the Reactor Vessel upper head (approximately 605°F). Given this lower temperature and the duration of operation of the DBNPS, the IMI nozzles would have a lower susceptibility for Primary Water Stress Corrosion Cracking (PWSCC) than nozzles located on the Reactor Vessel upper head, when applying the susceptibility formula provided in the NRC's Order EA-03-009 (February 11, 2003).

In Spring 2002, during the DBNPS Thirteenth Refueling Outage, a visual inspection was performed of the Reactor Vessel beneath the flange level. This inspection identified stains consisting of boric acid residue and rust/corrosion running down the external sides and bottom of the vessel. A video inspection was completed in June 2002. This inspection showed a number of the IMI nozzles having stains around the nozzle penetrations. The majority of the nozzles with stains were directly in the flowpaths. The stained deposits around the nozzle penetrations were flat and tightly adhering to the vessel surface. No indications of 'popcorn-type' deposits were observed around any of the penetrations. No wastage on the RV underside was found and no buildup of boric acid or corrosion products was found on top of the RV underside insulation panels. The video taken during the inspection is currently available onsite for NRC review. As described below, following discovery of the deposits, FirstEnergy Nuclear Operating Company (FENOC) staff investigated the condition, determined that the likely cause was from flow originating externally to the Reactor Vessel, and has planned a test to confirm the absence of pressure boundary leakage.

Investigation

Since the deposits were flat and tightly adhering to the vessel and nozzle surfaces, wire brushes and cleaning pads were used to collect deposit samples from two trails of residue on the lower sides of the Reactor Vessel and from twelve IMI nozzles on the bottom of the Reactor Vessel (see attached figure). The samples were collected in accordance with recommendations in Framatome ANP's (reactor vendor) document, "Recommended IMI Nozzle Inspection Plan".

The stain trails on the sides of the vessel had several potential sources:

1. Past leakage from the refueling canal through the cavity seal plate.
2. Past leakage from the refueling canal through the Reactor Vessel nozzle access covers.
3. Past leakage from cracks found in the Reactor Vessel Flange o-ring monitor lines.
4. Effluent from Reactor Vessel upper head decontamination and cleaning activities during the twelfth and thirteenth refueling outages.

The samples were analyzed for chemical composition in an effort to determine if the source of the deposits could be identified. Framatome ANP analyzed the samples using inductively coupled plasma mass spectroscopy. In addition, the DBNPS Chemistry staff analyzed the samples for radioisotopes. The limited amount of sample material available prevented analysis by other techniques. The elemental constituents and isotopic activities were determined for the fourteen samples, and were compared with two previous sets of deposit samples from the Reactor Vessel upper head that had exhibited leakage. Samples of paint and tape removed from the Reactor Vessel were also submitted to Framatome ANP for characterization. Other possible influences on the deposit sample constituents, such as sample collection materials and previous maintenance, were also considered.

The results of the analyses of these samples provided the following observations:

- The two flow trail samples were more difficult to dissolve than the nozzle deposits (as well as all previously analyzed deposits from the Reactor Vessel upper head).

- The two trail samples may not have accurately represented the composition of the flow streams. The trails were long and wide, and potentially there was a distribution of concentrations along the length and width of the flow trails.

- Some of the IMI nozzle deposits were higher in boron and lithium concentrations than the flow trail deposits, with very little discernable pattern to suggest concentration trends along the flow paths.

- The IMI Nozzle #3 lithium, and Nozzle #27 lithium and boron concentrations were significantly higher than the flow trail samples as well as the remaining nozzle samples (see attached graph). The peak normalized boron (39,469 parts per million) and lithium (12,548 parts per million) concentration were found at Nozzle #27. They were more similar to the lithium and boron concentrations in the deposit samples collected earlier in 2002 during the removal of Reactor Vessel upper head Control Rod Drive Mechanism Nozzle #2.

- The Cobalt-60 concentration was significantly higher in the flow train samples than in the IMI nozzle deposits. There was no distinguishable relationship between these values and the various nozzle locations to suggest any pattern of increasing or decreasing concentrations along a flow path.

- Iron-59 was present at detectable levels in the two flow trail samples, but not in any of the IMI nozzle deposit samples.

- Several minor species, including uranium, barium, thorium, strontium, and zirconium, were observed to have higher concentrations at several nozzle locations than in the flow trail samples. There were no clear concentration gradients for these elements that correlated with nozzle locations. However, the lack of activity from uranium, barium, thorium, strontium, and zirconium in these samples would indicate that the samples are from an environmental contamination source rather than from reactor coolant constituents.

- Decreasing lithium and boron concentrations in the samples from Nozzle #27 to #3 to #1 (i.e., from the more peripheral nozzle locations to the center location) would suggest a flow path, however, the southeast quadrant (90° to 180° location on the attached figure) flow sample concentrations were less than the concentrations at Nozzle #27. Nozzle #27 had the highest lithium and boron concentrations of any of the samples: lithium 12,548 parts per million, boron 39,469 parts per million.

- The total activity peaked in the southeast quadrant boric acid trail sample, then decreased in a downhill direction to Nozzle #27, Nozzle #3, and then Nozzle #1. This is consistent with the southeast quadrant boric acid trail providing material to those nozzles.

From the results of these analyses alone, it was inconclusive whether the flow trails and nozzle deposits had a common source. Accordingly, FENOC sponsored an IMI nozzle leakage simulation test.

Leakage Simulation Testing

Framatome ANP was contracted by FENOC to conduct an IMI nozzle leakage simulation test. The program consisted of leaking borated water at a controlled rate into a mockup of an IMI nozzle/penetration at temperatures and pressures representative of Mode 3 (Hot Shutdown), collecting the leakage for analysis, and visually inspecting the mockup assembly following each test period. Five tests were conducted with leakage rates from 0.0004 to 0.015 gallons per minute.

The test program had the following primary objectives:

- To determine whether very small leakage rates result in the buildup of boric acid deposits at the exit of the annulus between the IMI nozzle and Reactor Vessel,
- To identify residue deposit chemistry and volatile chemicals that would exit the crevice, and
- To assist in identifying where to look for potential boric acid crystals following the upcoming DBNPS Mode 3 normal operating pressure test.

Based on the results of this test program, the following conclusions were reached:

- If an unobstructed through-weld or through-wall leak path exists, it is highly likely that visible evidence of small leakage will be present on the outside of the IMI nozzle immediately outside of the Reactor Vessel. These deposits may appear "crusty" with a light yellow coloration. If the leak occurred in the recent past, i.e., days to weeks or months, significant levels of lithium should be present in the deposit in addition to high boron levels. Based on these test results, lithium concentrations would be expected to reach levels exceeding 15,000 parts per million.
- Relatively large leak rates (equivalent to 0.015 gallons per minute in the test nozzle mockup) should be easily detected visually by the presence of a considerable amount of rust-colored material extending down the nozzle.

Recent Events and Analysis

After obtaining the deposit samples, the Reactor Vessel was cleaned from the flange level down using high pressure water to remove remaining boric acid residue and rust/corrosion stains. After completion of these cleaning activities, refueling canal leakage occurred at one of the ventilation access covers on the new permanent seal plate and at one of cold leg access covers. Leakage from both of these locations left additional boric acid residue trails on the Reactor Vessel external sides and bottom. Visual inspection of these trails identified similar inconsistent boron deposit trends as noted in the original sample analysis results (i.e., boron deposits were identified on the bottom with no clear flow trails on the side, similar to the stains found on nozzles outside the flow trails during the visual inspection). Samples were obtained from both of these trails for chemical analysis and the remaining residue was cleaned from the Reactor Vessel. No consistent pattern was found in the data that could be used to predict the relative concentration of any key species in a flow trail of reactor coolant as it progresses down the sides of the vessel. These results were similar to analysis results from the flow trail discovered in the Spring of 2002.

In addition to the samples of the trails described above, wipe samples were taken at eight IMI nozzle locations. These wipes were analyzed and will be used to establish the baseline surface cleanliness of the sampled areas prior to performing the normal operating pressure test.

On April 12, 2003, South Texas Project Electric Generating Station (STP) Unit 1 identified small popcorn-type deposits at two incore nozzles on the bottom of the Reactor Vessel while conducting a visual inspection. These incore nozzles were later confirmed to contain cracks.

Chemical analysis of these STP deposits identified boron (between approximately 202,000 and 223,000 ppm) and elevated lithium (approximately 49,000 ppm) levels greater than nearly all of the concentrations found during the IMI nozzle simulated leakage test program discussed above. The boron-to-lithium ratio for the STP deposits was approximately a four-to-one.

Evaluation

As a result of the aforementioned inspections, sampling, chemical analysis, and testing, the FENOC staff has concluded the IMI nozzles are not leaking. The basis for this conclusion is as follows:

- There were no "popcorn" deposits of boric acid at the IMI nozzles, which would be expected if the nozzles were leaking, as shown by the tests at Framatome ANP, and the experience at STP.

- The concentrations of boron and lithium detected at the IMI nozzles were significantly less than would be expected if the IMI nozzles were leaking.

- In general, the nozzles in question were directly in the visible flow path of the boric acid down the side of the Reactor Vessel. Furthermore, the recent event involving refueling canal leakage indicates that nozzles can have stains as a result of flow down the side of the Reactor Vessel, even though the nozzles are not in the visible flow trails.

- The concentrations of contaminants varied significantly in the flow trail itself, among the nozzles, and between the nozzles and the flow trail. There was no consistent pattern that would identify leakage of the IMI nozzles as the source of the contaminants.

- The IMI nozzles have a lower susceptibility to PWSCC, as determined by the formula in the NRC's Order EA-03-009.

- No leakage from the IMI nozzles was observed as a result of the test at 250 psig.

This information provides reasonable assurance that the IMI nozzles are not leaking, and that the source of the contaminants around the IMI nozzles was from flow down the external sides of the Reactor Vessel. Furthermore, the recent event involving refueling canal leakage indicates nozzles can have deposits even though they are not in the visible flow paths.

Confirmatory Testing at Normal Operating Pressure

To confirm this conclusion, FENOC will perform additional inspections. As part of restart activities, the Reactor Coolant System will be taken to Mode 3 normal operating pressure and near normal operating temperature conditions for approximately seven days. Following plant cooldown, a crawler video inspection of each IMI nozzle penetration will be conducted. The results from this video camera inspection will be compared with the baseline video inspection performed after the final Reactor Vessel cleaning activities were completed. If signs of deposits or residue are found on the vessel or tube surface near the nozzle penetration, wipe samples will be obtained for chemical analysis. Boron and lithium concentrations and ratios from analysis of the wipe samples will be used to determine if the source of the deposits is potentially from an IMI nozzle leak.

If the deposits originally found around the IMI nozzle penetrations resulted from IMI nozzle leakage, the penetration annulus would already be full and additional deposits will likely be visible outside the annulus following the seven-day test. The prior cleaning activities performed on the vessel would not have removed the deposits inside the annulus area. If an actual IMI nozzle leak exists, chemical analysis of the wipe samples taken from any deposits identified after the seven day test should have elevated boron and lithium concentrations consistent with the values from the leak test program and the STP samples.

On-line Leak Monitoring

As a means of detecting leakage during normal plant operation, FENOC is installing the FLUS on-line leak monitoring system under the Reactor Vessel. The FLUS system is designed to detect changes in humidity between the Reactor Vessel bottom and the Reactor Vessel insulation. FLUS sensitivity tests will be performed during the seven-day normal operating pressure test. When operational, this on-line leakage detection system will assist in early detection if any appreciable leakage from an IMI nozzle were to occur.

Future Inspections

Following restart from the current extended Thirteenth Refueling Outage, similar inspections of the Reactor Vessel IMI nozzles will be performed each refueling outage, as discussed in FENOC's March 31, 2003, letter Serial Number 2833 response to NRC Bulletin 2001-01. In addition, FENOC will perform this inspection during the upcoming Cycle 14 mid-cycle outage.

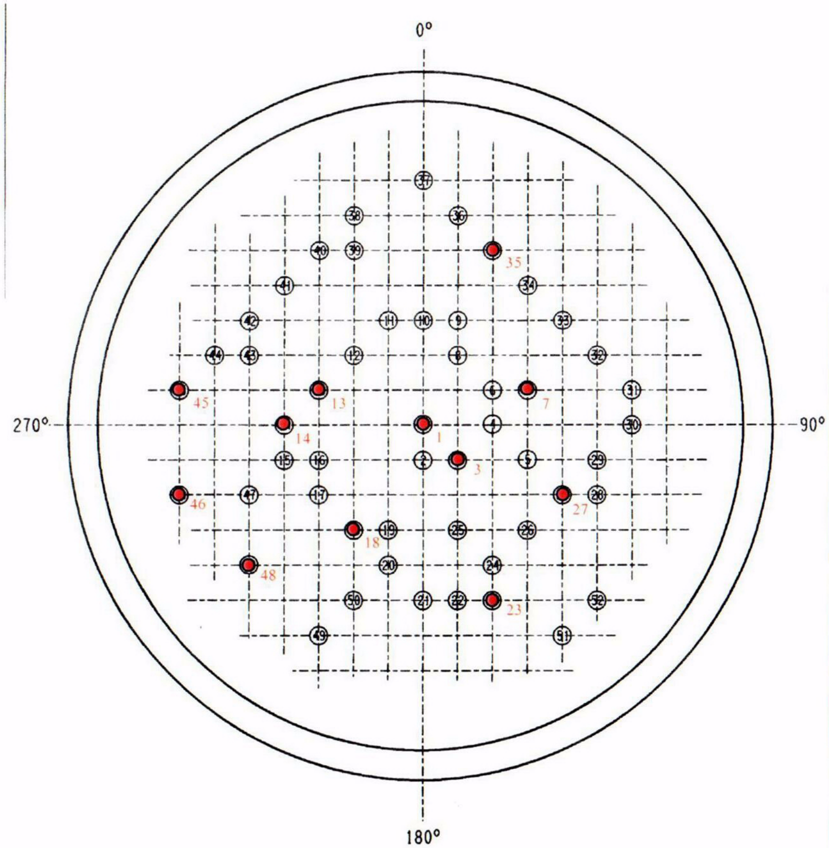
Conclusion

In summary, during the initial visual inspection of the IMI nozzles, no 'popcorn-type' deposits similar to those found at STP were identified around any of the penetrations. Boron and lithium concentrations in the samples taken from the IMI nozzles were below the concentrations predicted for a leaking IMI nozzle from the IMI nozzle simulated leakage test program, and well below the concentrations found in the STP deposits from an actual leaking incore nozzle.

The inspections, analyses and test that have been performed provide reasonable assurance that the rust/corrosion stains and boric acid residue found around several IMI nozzle penetrations during the initial visual inspection did not result from leakage from the IMI nozzles. This conclusion will be confirmed during the inspection following the seven day test at normal operating pressure.

Sampling of Deposits

- Nozzle sample locations (•)



INCORE INSTRUMENT CORE LOCATION MAP
BOTTOM HEAD INSIDE VIEW

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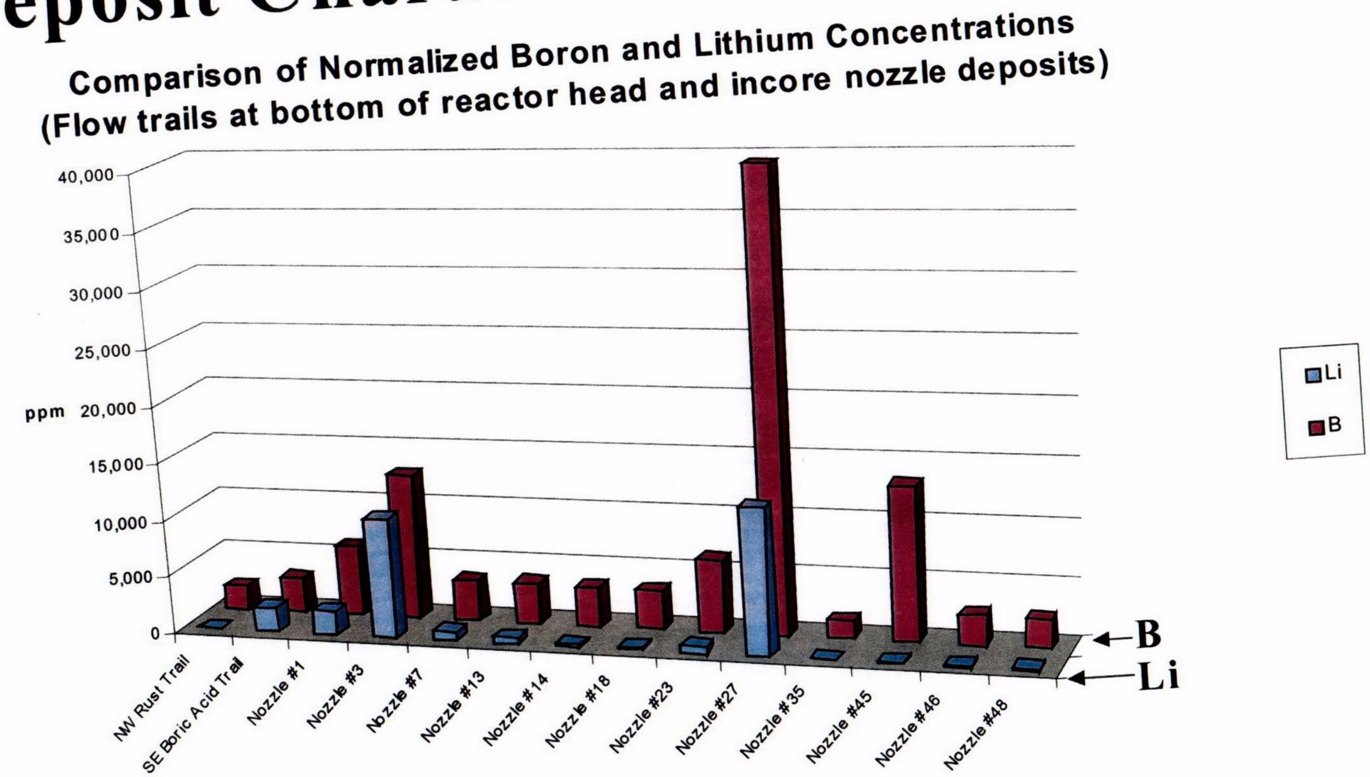
Deposit Characterization Summary



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Docket 50-346
License Number NPF-3
Serial Number 2973
Attachment 2

COMMITMENT LIST

THE FOLLOWING LIST IDENTIFIES THOSE ACTIONS COMMITTED TO BY THE DAVIS-BESSE NUCLEAR POWER STATION (DBNPS) IN THIS DOCUMENT. ANY OTHER ACTIONS DISCUSSED IN THE SUBMITTAL REPRESENT INTENDED OR PLANNED ACTIONS BY THE DBNPS. THEY ARE DECRIBED ONLY FOR INFORMATION AND ARE NOT REGULATORY COMMITMENTS. PLEASE NOTIFY THE MANAGER – REGULATORY AFFAIRS (419-321-8450) AT THE DBNPS OF ANY QUESTIONS REGARDING THIS DOCUMENT OR ANY ASSOCIATED REGULATORY COMMITMENTS.

Commitment	Due Date
Perform a visual inspection, consisting of a complete 360 degree examination of each IMI nozzle during the Cycle 14 mid-cycle outage. (source: cover letter and attachment)	Cycle 14 mid-cycle outage