December 2, 2003

Mr. Thomas Gurdziel
[HOME ADDRESS DELETED
UNDER 10 CFR 2.790(a)]

SUBJECT: REACTOR COOLANT PUMP LEAKAGE AT DAVIS BESSE

Dear Mr. Gurdziel:

This is in response to your e-mail to Christine Lipa dated February 6, 2003, and your letter #19 dated February 8, 2003, that discussed a concern with reactor coolant pump leakage at the Davis-Besse Nuclear Power Plant. It also addresses a concern you expressed in your letters #21 and #22, both dated June 13, 2003. Specifically you questioned the acceptability of the Davis Besse licensee only replacing the gaskets on two of four reactor coolant pumps. You also were concerned about restarting the plant with pumps having primary coolant leakage and whether that violated technical specification requirements. Finally, you were concerned that the utility was focused on describing where the leakage came from, rather than it being primary coolant leakage in order to avoid entering technical specification action statements.

These issues were extensively reviewed during the corrective action team inspection which occurred from March 17 through August 29, 2003. The results of this inspection will be documented in inspection report 50-346/03-10. However, answers to your specific questions are provided in the first enclosure to this letter and a detailed technical explanation of the inspection efforts on the reactor coolant pump gasket issue is provided in the second enclosure.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be made available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Should you have any questions regarding our findings, please contact me at (630) 829-9637.

Sincerely,

/RA by Christine Lipa Acting for/

John A. Grobe, Chair
Davis-Besse Oversight Panel

Enclosure(s): 1. Q&A
2. Detailed Information

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In the following paragraphs we have answered each of your questions in a question-and-answer (Q&A) format. We have then followed the Q&A's with a detailed technical explanation of what the NRC staff did to review the issues and why we reached the conclusions we did.

1) Q: If all four pumps were leaking and only two were fixed, then wouldn't that leave two pumps leaking when they started up again?

   A: Yes — if the statement were true that all four pumps were leaking and only two were fixed, then the remaining two would still leak when the plant restarted. However, the NRC staff could not corroborate the statement that all four pumps were leaking. In fact, the seven day normal operating pressure and temperature test showed that there was not any outer gasket leakage from any of the reactor coolant pumps.

2) Q: Wasn't there a condition report that documented that all four pumps had inner gasket leaks?

   A: Yes — Condition report 02-01523 discussed inner gasket leaks on two of the four pumps. This condition report asserted that there had been continuing inner gasket leakage on all four pumps for a number of years. The NRC staff determined that the licensee had performed a poor evaluation and had technically misunderstood the information they had obtained regarding gasket leakage.

3) Q: Isn't only zero primary coolant leakage acceptable at power?

   A: Not entirely — The Technical Specifications distinguish between types of primary coolant leakage, based on the definitions in the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (the ASME Code). The Technical Specifications reflect the ASME Code criteria that reactor coolant pressure boundary leakage be "zero." However, in addition to pressure boundary leakage, the Technical Specifications also address "identified" and "unidentified" primary coolant system leakage. The allowable values for these parameters are ten gallons per minute and one gallon per minute, respectively.

4) Q: Why isn't a leak through the first gasket of the reactor coolant pumps considered a primary coolant leak?

   A: The short answer is because it is isolated. A more complete answer is that the vendor provided a double gasket to extend the life of the component. The outer gasket provides a fully redundant sealing surface should the inner gasket begin to leak.

5) Q: So only outer gasket leakage is considered primary coolant leakage?

   A: Again, not entirely. The ASME Code excludes gasket leakage from the primary coolant pressure boundary leakage category (the one with the "zero leakage" acceptance criteria). So even if an outer gasket leaks primary coolant, that leakage is classified as either "unidentified" or "identified" leakage.

6) Q: If the reactor coolant pump gaskets aren’t part of the reactor coolant pressure boundary, what is?

A: The pump casing and cover are part of the reactor coolant pressure boundary. Additionally, the studs which hold the two together are part of the pressure boundary. These studs are subject to inservice inspection and the NRC staff confirmed that this inservice inspection did occur.

7) Q: What types of gaskets are used in the reactor coolant pumps?

A: Two of the four pumps (pumps 1-1 and 1-2) had their Flexitallic gaskets replaced with Inconnel gaskets. The remaining two pumps still have Flexitallic gaskets in them. These gaskets are approximately 20 years old and are scheduled to be replaced during the next refueling outage. The vendor has been consulted and stated that the gaskets should last for at least another operating cycle. None of the pumps use o-ring type gaskets.

8) Q: What is the arrangement of gaskets for the reactor coolant pump cover to casing gaskets?

A: The best way to answer this question is to refer you to the enclosed drawing. The gaskets run parallel to each other. Normally the inner gasket provides a sealing surface; however, in the event of its failure, the outer gasket is fully redundant and provides the same seal.

9) Q: Are the original design requirements of the gaskets in use being met?

A: Yes — Since the original design requirement is to provide a sealing surface, and that is occurring.

10) Q: Are any recesses or grooves for the gaskets filled with boron so that they do not provide adequate clearances?

A: This condition was not found on the two pumps which were refurbished. Instead, on the 1-1 pump, the opposite condition was found (that the recesses were larger than necessary, such that the gasket did not provide a good sealing surface.)

11) Q: Have any studs (on the reactor coolant pumps) been replaced because of a change in original characteristics due to age, radiation, or overtightening? ?

A: No — The NRC staff confirmed that the retensioning of the reactor coolant pump studs which occurred in 1996 was within ASME Code allowables. Therefore, no studs had to be replaced due to overtightening. The staff believes that during the recent (2003) overhaul of the 1-1 pump, one or two studs may have been replaced as a preventive measure, due to minor boric acid corrosion; however, the corrosion was not significant enough to affect the reactor coolant pressure boundary. No studs have been replaced on the other pumps.

12) Q: Is the torquing of the reactor coolant pump bolts controlled? Do they use calibrated torque wrenches?

A: Yes the tensioning of the reactor coolant pump studs is controlled by both work order and procedure. Calibrated tools are used and these tools are checked on a regular basis. These tools are listed in the work packages used for any reactor coolant pump stud work.

Detailed Information

1. Reactor Coolant Pump Inner Flange Gasket Leakage

A March 28, 2003, article in the Toledo Blade newspaper stated that the four Davis Besse reactor coolant pumps were prone to leaking highly corrosive borated water and the licensee had only tested and was only replacing the gaskets for reactor coolant pumps 1-1 and 1-2. The article cited condition reports and memos as the source for the information.

Reactor Coolant Pump Inner Gasket Leakage

During the corrective action team inspection, specialists from the regional office reviewed condition reports 02-01523, 02-03668, and 03-04018 which documented an apparent continuing problem with RCP inner gasket leakage. The inspectors determined that the cause evaluations for these condition reports did not provide an accurate technical justification as to why the gaskets on all four RCPs needed replacement. However, the inspectors also noted that the licensee did not provide a technical justification for the decision to replace the gaskets on only two of the four pumps. The evaluations, especially the one performed for CR 02-01523, were based on leak testing that: (1) did not use the same methodology from outage to outage; (2) did not attempt to normalize the data from outage to outage; (3) did not consider the impact of reactor coolant pressure and temperature conditions on the test results; and (4) was only intended to verify that the leak detection lines were open and not blocked. The inspectors were concerned that the licensee did not recognize these inconsistencies in performing and approving the evaluation and did not appear to understand the physical phenomena that the pumps were undergoing when the tests were performed. The justification for not replacing the gaskets was based on a vendor letter which accepted restart even with outer gasket leakage.

Because of the attention which this issue has received, including front page articles in local papers, the NRC inspectors performed an independent review of the gasket leakage issue. The inspectors were concerned with the dichotomy between the evaluations in the condition reports and the planned actions.

Background: The inspectors obtained the as-left leakages (those seen during startup) for all the pumps by reviewing copies of the actual tests and test log books. The inspectors also interviewed the test engineers about the test methodology. For each leakage, the inspectors noted the source of the information, the original units specified, and any other pertinent information.

10TH REFUELING OUTAGE (1996): The inspectors interviewed the engineer who has had the responsibility of implementing the American Society of Mechanical Engineers (ASME) Section XI inservice testing program since the 10th refueling outage. The engineer has the responsibility for implementing the program for the second inservice inspection interval, which was approved by NRC between the 9th and 10th refueling outages. One of the inspections required by the second inservice inspection interval was a VT-2 examination of the RCP casing flanges. The engineer told the inspectors

that boric acid was noted around the top of RCP 1-1 during the VT-2 walkdown. Since the system was completely depressurized, the engineer requested the help of the containment local leak rate test engineer in performing a VT-2 examination of the leakage detection system. The inservice inspection engineer explained that the primary purpose of this examination was to determine whether the leakage detection line was clear. The local leak rate test engineer used an air pressurization system to show that leakage line could be pressurized to 50 psig, and a leak rate established on all four pumps. The inservice inspection engineer stated that the affected studs on the 1-1 pump were removed and VT-3 examinations were performed. Additionally, all the studs on all four pumps were tightened to reduce the leakage. Air leakage tests were performed on all four pumps following the stud torquing.

For the 10th refueling outage, inspectors reviewed the inservice inspection engineer's original test log. The tests were performed during the refueling outage while the reactor coolant system was cold and depressurized. The tests were conducted with air pressurized to 50 pounds per square inch gauge (psig), and the leakage was measured in standard cubic centimeters per second. The as-left leakage for pump 1-1 was 15 standard cubic centimeters per second, while the other 3 pumps had zero leakage.

11TH REFUELING OUTAGE (1998): The test engineer stated that during this refueling outage the leakage detection system was checked for leakage by opening the drain lines during startup and leaving a collection container for approximately an hour. The amount of water collected was then roughly estimated. Again, the primary purpose of the test was to show that the leakage detection system was operational, as required by the ASME Code. The results showed some leakage, proving the leakage detection system was not blocked. The test engineer stated that he was not aware of any boric acid leakage being identified around any of the pump casing studs.

For the 11th refueling outage, the NRC reviewed the test engineer's informal copy of the test procedure. No pressures were recorded, however, the procedure required the system to have been pressurized to greater than 250 psig for an hour. The leakages ranged from a "pint" to a "half gallon" over an hour period.

12TH REFUELING OUTAGE (2000): During this refueling outage, the licensee again performed a VT-2 examination of the 1-1 RCP casing studs. Three studs were found to have traces of boron on them, and an alternate ultrasonic examination of the studs was performed. The licensee also attempted to better quantify the leakage past the inner gasket. The leakage was measured in milliliters and the pressure at which the measurements performed was recorded.

The inspectors obtained and reviewed copies of test DB-PF-03065 performed on April 2, 2000, for all four RCPs. The test obtained three values: the accumulated leakage when the valves where first opened, the steady state flow with the valves opened, and flow collected with the valves isolated and then reopened approximately one hour later. The tests were conducted at 265 psig for the 1-1 and 1-2 pumps and 1500 psig for the 2-1 and 2-2 pumps. The leakage ranged from 0.004 gallons per minute (gpm) on pump 1-1 to 0.013 gpm on pump 2-1.

13TH REFUELING OUTAGE (2002 - 2003): During this refueling outage, water tests were performed on RCPs 1-1 and 1-2 during the cooldown. Later in the outage, air tests were performed on RCPs 2-1 and 2-2 . Due to boric acid leakage again being found around the 1-1 RCP casing studs, the licensee decided to replace the gaskets on the 1-1 and 1-2 RCPs. The justification for waiting until refueling outage 14 for the other two pumps appeared to be initially based on parts availability, later justified on the limited leakage from these pumps, and finally based on a letter from the vendor.

For the 13th refueling outage, the inspectors determined that the as-found values of 0.011 gpm for RCP 1-1 and 0.032 gpm for RCP 1-2 were taken during the cooldown at a pressure of 893 pounds, as compared to the 265 pounds from the previous startup. These pumps were then disassembled for repairs. As-left leakage tests for the pumps, following gasket replacements, showed no as-left leakage.

The inspectors also obtained and reviewed copies of tests DB-PF-03065 performed on August 27, 2002, for RCP 2-2, and on August 28, 2002, for pump 2-1. The inspectors noted that both air tests showed a leakage of zero standard cubic centimeters per minute. For both the water tests on the 1-1 and 1-2 pumps and the air tests on the 2-1 and 2-2 pumps, no measurement was made of any initial leakage. During discussions with the engineer who performed the testing, the engineer stated that he did not remember any water being present when the valves were opened.

In August 2003, following the first pressurization of the reactor coolant system (to approximately 250 psig), the licensee observed boron on the studs for RCP 2-2. This was after the pumps had been thoroughly steam cleaned. The licensee opened the inner gasket leakoff line and found the line pressurized with significant initial leakage, which slowly decreased to a "trickle." This was documented in CR 03-06296.

NORMAL OPERATING PRESSURE AND TEMPERATURE TEST: From September 21 through September 30, 2003, the licensee brought the reactor coolant system to its normal operating pressure of 2210 psig and normal operating temperature of 586 °F by running the RCPs. At approximately 400 pound increments during the pressurization and on five occasions once full pressure and temperature were realized, the licensee checked pumps 2-1 and 2-2 for both inner gasket leakage (by opening the gasket leakoff line isolation valve) and outer gasket leakage (through examination of the RCP studs). Pumps 1-1 and 1-2, which were overhauled during this outage, were also checked for inner gasket leakage during the test. The results of the tests were:

- Reactor Coolant Pumps 1-1 and 1-2
  No leakage past the inner gasket occurred during plant heat-up, normal operating temperature and pressure, or cooldown. The inner and outer gaskets were replaced with new gaskets during this outage.

- Reactor Coolant Pump 2-1
  Inter-gasket leak checks indicated that slight leakage past the inner gasket occurred during heat-up, normal operating pressure and temperature, and cooldown. No boric acid was found at the case to cover joint following cooldown from the Mode 3 NOP/NOT test. No outer gasket leakage was noted.

- <u>Reactor Coolant Pump 2-2</u>
  Inter-gasket leak checks indicated slight leakage past the inner gasket during heat-up. The leakage stopped after a day at normal operating temperature and pressure. No leakage occurred during the cooldown. The case to cover inspections identified four discrete particles of boric acid forming during the heat-up. The particles did not grow during the normal operating temperature and pressure test or during cooldown.

Based on these results and vendor recommendations, the licensee determined that reactor coolant pumps 2-1 and 2-2 pump cover to casing gaskets performance was acceptable for one more operating cycle.

Issue Evaluation:

THERMAL EXPANSION OF DIFFERING MATERIALS: The inspectors determined that a physical property, the coefficient of thermal expansion, of the pump casing and the studs was affecting the gasket leakage rates. As the stainless steel casing has a substantially higher coefficient of thermal expansion than the carbon steel studs, it expands and contracts at a different rate from the studs. Added to this is a temperature differential through the casing, which differs, dependent on the point in the startup or the cooldown cycle when the measurement is being taken. The net result of the different expansion and contraction rates, with temperature effects, is that the load on the gasket is changing until the pump is either completely at full pressure and temperature or completely cooled. The inspectors noted that, due to the nature of the phenomena, some parts of the gasket might be under more loading than others at any given time of the thermal transient. Due to the changes in gasket loading, leakage has been occasionally observed during thermal transients that is not necessarily present when the pump is at power. The inspectors noted that the vendor mentioned this phenomenon in the second paragraph of its July 2, 2002, letter.

PURPOSE OF INNER AND OUTER GASKETS: The inspectors determined that the design of both the inner and outer gaskets was to seal against full reactor pressure. While normally, the inner gasket provides the seal, the outer gasket is also designed to do so. Only if the outer gasket fails does the reactor coolant have a chance to affect the reactor coolant pressure boundary, which is provided by the casing to cover studs.

The inspectors also noted that leakage past either the inner or outer gasket was not pressure boundary leakage, per the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). The Code specifically excludes gaskets from pressure boundary leakage. Instead any leakage past the OUTER gasket would be categorized as either identified or unidentified reactor coolant leakage, and would be subject to the technical specification limits. Leakage past the inner gasket is not considered to be a safety concern. Neither the inner or the outer gasket is considered to be important to safety and neither component is credited with having a safety function in the USAR.

The inspectors determined that a catastrophic failure of the inner gasket during an operational cycle should have no consequences, as the outer gasket should continue to

hold. If the outer gasket also failed, then the licensee would have to comply with the technical specifications and shut down the plant.

LEAKAGE HAVING THE POTENTIAL TO AFFECT REACTOR COOLANT PRESSURE BOUNDARY: The inspectors noted that only RCP 1-1 showed leakage past the outer gasket prior to the 13th refueling outage. According to the licensee's records, and the photographs taken of pump 1-1 at the start of the 13th refueling outage, only minor traces of boron accumulation were identified past the outer gaskets and on the studs (the actual pressure boundary surface). The inspectors confirmed that 100 percent of the studs on all four pumps were examined for boric acid accumulation and none was found. Both the 1-1 and 1-2 pumps were dismantled and refurbished during the outage and new gaskets were installed. The inspectors also determined that no outer gasket leakage was identified during VT-2 examinations during the seven day normal operating pressure and temperature test.

In mid-August 2003, the licensee identified boron crystals around the studs on RCP 2-2. This was following steam cleaning of the pump and then a slight pressurization. The inspectors discussed the issue with a knowledgeable licensee engineer and determined there were two possibilities that accounted for the presence of the boron: first, the boron might have "leached out" from the pump surface following the steam cleaning; second, the outer gasket might have developed a leak, due to the number of thermal transients which it had experienced. The first hypotheses was proven to be true during the seven day pressure test.

EVALUATION OF INNER GASKET LEAKAGE: The intent of the tests performed from 1996 to 2002 was to show that the leakage detection system was not blocked. For this purpose, any sign of leakage was acceptable. The test was not designed to quantify leakage past the inner gasket, and because the test was performed during periods of temperature and pressure transitions, the results were not comparable across outages.

The inspectors noted that the licensee's test methodology permitted the water leakage measurements to be taken during times of thermal transient, with no constraints on temperature or pressure. While this was sufficient and reasonable for the original test purpose of determining that the line was not blocked, it was insufficient to allow the use of the results to predict inner gasket leakage, because of the phenomena discussed above. The only values which could actually be compared were the air leakage rates taken while the reactor was cold and depressurized. In discussions with the test engineers, the inspectors determined that they were not aware of the effects of the pump casing thermal expansion properties on the gasket loading.

The inspectors also noted that the normal operating pressure and temperature test included inspections of the RCPs, both at the gasket leakoff lines and at the studs. These inspections were conducted prior to, during and following reading normal operating pressure and temperature. This test showed that there was no outer gasket leakage and that the inner gasket leakage was minor, occurred primarily during the pressurization period and stopped or significantly slowed once the pumps reached an equilibrium temperature.

This test confirmed the inspectors qualms about the quality of the condition report evaluations, as it directly contradicted the claims made in those evaluations. However, the licensee also did not have a good technical justification to support the acceptability of the slight inner gasket leakage that occurred.

Because the results of the normal operating pressure and temperature test showed that there was no leak past the outer RCP gasket, the inspectors concluded that there was no safety issue. The inspectors did identify a performance deficiency in regard to the licensee's failure to adequately analyze, either positively or negatively, the consequences of a continuing **inner** gasket leak. As there was some very slight inner gasket leakage from pump 2-1, the inadequate evaluations would not provide support for any licensee action except replacing the gaskets during the current outage. Based on the inspector's evaluation, the inner gasket leakage was inconsequential. Additionally, the licensee showed through the normal operating pressure and temperature test that there was no outer gasket leakage. Thus, not replacing the gaskets on pumps 2-1 and 2-2 until the 14th refueling outage was acceptable. Therefore, the technical issue could be considered minor. The inspectors reviewed this issue under the significance determination process and determined that the finding would fall under the "Barrier Integrity" cornerstone. Because the licensee proved that the outer gaskets maintained their integrity, this issue screened out of the significance determination process as having very low safety significance.

Because the gaskets are non-safety related components, they are not required to be covered by the Appendix B quality assurance program. Therefore, no violation of NRC requirements existed.

2. Reactor Coolant Pump Flange Studs

In conjunction with review of the inner gasket leakage issue, the NRC specialists also evaluated whether the RCP flange studs had been overtorqued when they were retensioned in 1996 to stop the outer gasket leakage on RCP 1-1.

Background: The inspectors reviewed the work histories for the RCPs and determined that RCP 1-1 showed evidence of outer gasket deterioration. The inspectors ascertained that in 1996, leakage was found around several studs on pump 1-1. At this time, the stud tension on all four RCPs were redone to a higher value provided by the vendor. The inspectors also determined that leakage was found around these same studs on RCP 1-1 in 2000.

Issue Evaluation: The inspectors reviewed condition reports 02-01523, 02-07402 and 02-08759 and noted the following items which were not considered during the licensee's review:

OVERSTRESSING OF REACTOR COOLANT PUMP CASING STUDS: The inspectors independently reviewed calculations performed by the vendor, Flowserve, and compared the results with the 1996 retensioning values. Based on this review, the inspectors determined that the casing studs were not overstressed following the 1996 retensioning. The inspectors evaluated this concern by using stud elongation as a measure for determining whether the applied stresses were within the allowable; this was done as the 1996 retensioning results were given in terms of elongation. The

inspectors noted that the vendor determined, in calculation SR-0964, the maximum ASME Code allowed stud elongation, on a quadrant average, was 24.3 mils or 0.0243 inches. The inspectors performed basic calculations to independently verify that this value was appropriate.

The inspectors reviewed the 1996 work orders and determined that the installed quadrant average was 23 mils, which was below the calculate Code allowable of 24.3 mils. Therefore, the inspectors concluded that the reactor coolant casing studs were not overstressed.

IDENTIFICATION OF INAPPROPRIATE CLOSURE OF CONDITION REPORT: During initial review of the Flowserve calculation, the inspectors determined that it only addressed the condition for the 1-1 and 1-2 pumps, which were refurbished and had new gaskets installed. The inspectors determined that the condition report evaluating the potential for the studs on all four pumps being overstressed (02-08759) had been closed. The inspectors questioned the acceptability of the calculation to close the condition report as it did not address pumps 2-1 and 2-2. In response to the inspector's concerns, the licensee went back to the vendor, who provided a letter which evaluated the acceptability of the stress levels for the remaining two pumps. After further questioning by the inspectors, the licensee attached this letter to the condition report. The inappropriate closure will be discussed as an example of a violation in Inspection Report 50-346/03-10.

Definition of Terms

- American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section III: The standards which define the acceptance criteria for design of nuclear systems.

- ASME Code, Section XI: The portion of the ASME Code which defines the acceptance criteria for examination of piping, pumps and valves, including that designed to Section III. Licensees are required to commit to a program implementing a Section XI inspection program by 10 CFR 50.55a(g).

- Coefficient of Thermal Expansion: A property of the materials used to make the pumps and gaskets. Different materials expand and contract at different rates during temperature changes, dependent upon their coefficient of thermal expansion. The coefficients are generally available in material property tables.

- Gasket Leakoff Line: A drain line between the inner and outer gaskets installed in order to allow monitoring of leakage from the inner gasket. The gasket leakoff line is not part of the reactor coolant pressure boundary. Any leakage past the isolation valves would be considered either as identified or unidentified reactor coolant system leakage and would be subject to the technical specification limitations.

- Gaskets, Inner and Outer: Although provided to prevent leakage of reactor coolant at the mechanical junction of the casing to cover, gaskets are not considered part of the reactor coolant pressure boundary, per the ASME Code. Both the inner and outer gasket are designed to take full reactor system pressure. If the inner gasket starts leaking, then the outer gasket provides the seal and the inner gasket leakage is collected in the gasket leakoff line.

- Identified Leakage: Leakage, such as from pump seal or valve packing, that is collected and measured, or leakage into the containment which is not reactor coolant pressure boundary leakage, has been specifically located and the rate of which has been quantified. The Davis Besse Technical Specifications limit identified leakage to 10.0 gallons per minute.

- Reactor Coolant Pressure Boundary: All pressure vessels, piping, pumps, and valves which are part of the reactor coolant system, or connected to the reactor coolant system, up to and including: (a) the outermost containment isolation valve in system piping that penetrates the primary reactor containment; (b) the second of two valves normally closed during normal reactor operation in system piping that does not penetrate primary reactor containment; and (c) the reactor coolant system safety and relief valves. Bolting and studs used to close mechanical joints are considered to be pressure boundary material.

- Reactor Coolant Pressure Boundary Leakage: The ASME Code, Section XI, considers reactor coolant pressure boundary leakage to be any leakage from: pressure vessels, pipes, the body of any pumps or valves, and any flanges either welded or bolted that are

within the defined reactor coolant pressure boundary. Gaskets, seals and packing are specifically excluded from pressure boundary leakage consideration. Per both the ASME Code and the Davis Besse Technical Specifications, no reactor coolant pressure boundary leakage is allowed, no matter how minute.

- Reactor Coolant Pump: The pump which is used to provide forced circulation of water from the reactor to the steam generator and back again. The safety function of the pump is to remain intact as part of the reactor coolant pressure boundary. Based on the definition of the reactor coolant pressure boundary, only the pump body and the casing to cover studs are part of the reactor coolant pressure boundary.

- Second Inservice Inspection Interval: The inservice inspections of the reactor coolant pressure boundary are performed to a specific version of the ASME Code. For each ten-year inspection interval, as required by 10 CFR 50.55a(g), the licensee submits a proposed inspection plan to the NRC, including updates and relief requests. The second inservice inspection interval began in 1990, and as part of the process, the licensee updated the Code being used to the 1986 version. This update required examination of bolted connections, something which had not been done at during the previous inspection interval. A relief request, RR-A7, allowed examination of studs for evidence of leakage rather than performing a Mode 3 walkdown with insulation removed.

- Unidentified Leakage: Leakage being picked up by a leakage detection system where the licensee has not identified the source of the leakage. The Davis Besse Technical Specifications limit this leakage to 1.0 gallon per minute. Gasket leakage past the gasket leakoff line isolation valves, would initially fall into this category until it was located and quantified.

- VT-2 Examination: Visual examination to detect evidence of leakage from pressure retaining components, with or without leakage collection systems.

- VT-3 Examination: Visual examination of the general mechanical and structural condition of components and their supports by verifying parameters such as clearances, settings, and physical displacements; and to detect discontinuities and imperfections, such as loss of integrity at bolted or welded connections, loose or missing parts, debris, corrosion, wear, or erosion.

LIST OF DOCUMENTS REVIEWED

Documents Reviewed

- Condition Report 00-0669; Potential Non-Compliance Against the ASME Code; dated April 1, 2000
- Condition Report 00-0699; Steady State Leakage from Three of Four Reactor Coolant Pump Gasket Drain Lines; dated April 2, 2000
- Condition Report 00-0869; Leakage at the Bolted Connection on Reactor Coolant Pump 1-1; dated April 10, 2000
- Condition Report 00-1089; Relaxation of Reactor Coolant Pump Casing Studs since Refueling Outage 11; dated April 20, 2000
- Condition Report 02-00164; ASME Relief Request for the 13^{th} Refueling Outage; dated January 16, 2002
- Condition Report 02-01517; Containment Inspection Plan Not Fully Implemented; dated April 10, 2002
- Condition Report 02-01523; Reactor Coolant Pump 1-1 and 1-2 Leakage at Gasket Drain Lines; dated February 16, 2002
- Condition Report 02-01691; Inspection Plan IP-M-028 Findings; dated April 25, 2002
- Condition Report 02-01915; Inspection Plan IP-M-028 (Extent of Condition) Examination Findings; dated May 6, 2002
- Condition Report 02-02143; Inspection Plan IP-M-028 (Extent of Condition) Examination Findings; dated May 17, 2002
- Condition Report 02-03668; Reactor Coolant Pump Casing to Cover Joint Leakage; dated August 3, 2002
- Condition Report 02-05096; Reinspection of RCP21OUT-5-RI (Pump 220, Reactor Coolant Pump 2-1 Discharge); dated August 26, 2002
- Condition Report 02-05159; Reinspection of Reactor Coolant Pump 2-1 Casing Closure Studs and Bolting; dated August 26, 2002
- Condition Report 02-05881; Reactor Coolant Pump 2-2 Casing Closure Studs and Bolting; dated September 12, 2002
- Condition Report 02-07402; Reactor Coolant Pump Vendor Technical Manual Closure Stud Elongation Specification Should be Updated; dated October 4, 2002

- Condition Report 02-08759; Potential Overstress Condition in Reactor Coolant Pump Casing Joint; dated October 28, 2002

- Condition Report 02-09870; EN-DP-01501, RCP22OUTI-1, Reactor Coolant Pump 2-2 and Outlet Pipe; dated December 5, 2002

- Condition Report 03-06296; Boric Acid Identified on Reactor Coolant Pump 2-2; dated August 5, 2003

- Drawing 7749-M-508-74-8; Sheets 1 and 2, Byron-Jackson Reactor Coolant Pump; Revision D

- Enclosure 7 of DB-MM-09117; R0; Tensioning Data Sheet, from Work Orders 7-96-0650-01, -02, and -05 for Reactor Coolant Pumps 1-1, 1-2, and 2-1, Respectively

- Flowserve Calculation SR-0964; Cover Gasket Upgrade Verification for Davis Besse Primary Coolant Pumps; Revision 1; dated February 3, 2003

- Intra-Company Memorandum NPE 01-00071; OE 12074 – Boric Acid Corrosion of Carbon Steel Components at the Reactor Coolant System Pressure Boundary; dated April 27, 2001

- Intra-Company Memorandum NPE 02-00227; Reactor Coolant Pump Issues; dated August 9, 2002

- Intra-Company Memorandum NPE 03-00047; Reactor Coolant Pump Status to August 9, 2002, White Paper; dated April 3, 2003

- Operating Experience Report 15262; Byron Jackson Reactor Coolant Pump Casing to Cover Leakage; dated January 23, 2003

- Letter; Reactor Coolant Pump Inter-Gasket Leakoff, Flowserve to First Energy; dated July 2, 2002

- Letter; Inspection of Davis Besse Reactor Coolant Pumps 2-1 and 2-2, Flowserve to First Energy; dated September 16, 2002

- Letter; Davis Besse Nuclear Power Station, Unit 1 - Requests For Relief for the Third 10-year Interval Inservice Inspection Program Plan (TAC No. MB1607); NRC to First Energy; dated September 30, 2002

- Letter; Davis Besse Reactor Coolant Pump Casing Joint Analysis; Flowserve to First Energy; dated April 24, 2003

- Maintenance Work Order 1-87-3304-00; Check Stud Elongation on All Four Reactor Coolant Pumps; datedJuly 21, 1988

- Maintenance Work Order 1-97-0553-00; Check P36-1 Casing Studs; dated May 14, 1998

- Maintenance Work Order 1-97-0553-01; Check P36-2 Casing Studs; dated May 14, 1998
- Maintenance Work Order 1-97-0553-02; Check P36-3 Casing Studs; dated May 14, 1998
- Maintenance Work Order 1-97-0553-03; Check P36-4 Casing Studs; dated May 14, 1998
- Review of Maintenance Work Order History of Reactor Coolant Pumps
- Surveillance DB-PF-03065; Pressure and Augmented Leakage Test, Completed April 2, 2000; August 27, 2002; and August 28, 2002
- Test Engineer Log Book
- Work in Progress Log for Work Order 7-96-0650-06 on Reactor Coolant Pump 2-2

Reactor Coolant Pump Cross Sectional View

Note: This drawing is an idealized cut-away to show relative location of inner and outer gaskets, gasket leakoff line, and flange studs. It is not completely to scale and does not show all pump internals.