From: Jon Hopkins
To: Dick, George
Date: 6/21/05 12:49PM
Subject: Re: Fwd: RESPONSE TO BYRON LSIV RAI

From: Thomas Scarbrough
To: Jon Hopkins
Date: 6/8/05 12:04PM
Subject: Re: Fwd: RESPONSE TO BYRON LSIV RAI

Jon,

Attached is the combined input from Frank Orr and me for the Director's Decision on the Byron 2.206 Petition.

Please obtain concurrence from Reactor Systems Branch, and Mechanical and Civil Engineering Branch, when the final package is prepared.

Thanks.
Tom

>>> Jon Hopkins 06/01/05 10:43AM >>>
Attached is Byron response to LSIV RAI (2.206).

Please review promptly.

Thank you, Jon
(I am now the Byron/Braidwood PM).

CC: David Fischer; Frank Orr; John Nakoski

Mail Envelope Properties (42B844FF.319 : 6 : 20443)

Subject:	Re: Fwd: RESPONSE TO BYRON LSIV RAI
Creation Date:	6/21/05 12:49PM
From:	Jon Hopkins
Created By:	JBH1@nrc.gov

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T. Scarbrough
Frank Orr
June 8, 2005

INPUT FOR DIRECTOR'S DECISION ON 10 CFR 2.206 PETITION ON REVIEW OF BYRON UNIT 1 RCS COLD LEG LOOP STOP ISOLATION VALVE 1RC 8002C

I. Introduction

On March 2, 2005, a member of the public filed a petition under 10 CFR 2.206 requesting enforcement action for the licensee's failure to comply with 10 CFR 50 Appendix B, Criterion XVI, "Corrective Action," in that Reactor Coolant System (RCS) Cold Leg Loop Stop Isolation Valve (LSIV) 1RC 8002C at Byron Unit 1 had been broken for at least 6 years and had not been repaired.

In response to NRC staff questions during telephone conferences, the licensee submitted additional information in a submittal dated March 5, 2005. On March 21, the NRC staff held a public meeting with the licensee to discuss the structural integrity of RCS Cold Leg LSIV 1RC 8002C at the Region III office in Lisle, IL. The NRC staff subsequently determined that a safety concern did not exist with the restart of Byron Unit 1.

On May 4, the NRC sent a request for additional information to the licensee related to RCS Cold Leg LSIV 1RC 8002C. On May 27, the licensee provided the requested information. The NRC staff has completed its review of the 10 CFR 2.206 petition on RCS Cold Leg LSIV 1RC 8002C at Byron Unit 1. The NRC staff's review and conclusions regarding the licensee's actions in response to the performance issues with 1RC 8002C at Byron Unit 1 are described below.

II. Background

RCS Cold Leg LSIV 1RC 8002C at Byron Unit 1 is located in RCS Cold Leg Loop C upstream of the pressurizer spray line, Chemical Volume and Control System (CVCS) letdown line, and charging and ECCS injection lines. Byron 1RC 8002C is a Westinghouse 27.5-inch double-disc gate valve operated by a Limitorque SBD-4-80 motor actuator. The gate assembly consists of two spring-loaded discs that fit around the valve stem head with the discs held in place by two valve guides that are located in a groove in the valve body with Spirol pins. These pins are susceptible to stress corrosion cracking. Each guide is channel-shaped 5/8-inch 410 Stainless Steel with an overall size of 4 x 39 x 1.75 inches and weighs approximately 50 pounds. During refueling outage B1R10 (fall 2000) at Byron Unit 1, the licensee welded channel-shaped blocks with dimensions of 2.4 x 0.44 x 0.38 inches at the bottom of guides in the cold leg LSIVs to prevent the guides from moving out of position.

The licensee indicated that 1RC 8002C has had a long history of requiring multiple strokes to fully close. In particular, the torque switch in the motor actuator for 1RC 8002C typically would trip on high torque and stop the motor prior to full closure during initial attempts to close the valve. With repeated closure attempts, the valve would stroke farther before the torque switch tripped and, eventually, the valve would reach the fully closed position. For example, the valve required two, six, three, and two strokes to achieve the fully closed position during refueling outages B1R9 (spring 1999), B1R11 (spring 2002), B1R12 (fall 2003), and B1R13 (spring

2005), respectively. The licensee also reported that the loose parts monitoring system had identified noises near 1RC 8002C in the fall of 2001.

In addition to the experience with 1RC 8002C, the licensee indicated that 1RC 8002A in RCS Cold Leg Loop A at Byron Unit 1 failed to close during refueling outage B1R09. The licensee reported that sounds near this valve were heard on the Loose Parts Monitoring System prior to the valve failure. The licensee disassembled 1RC 8002A and found that the guide pin had failed and that one valve guide had dropped and was contacting the valve seat. The licensee repaired 1RC 8002A and tested the other LSIVs during refueling outage B1R09. The licensee also stated that motor diagnostics indicated that the performance of 1RC 8002D in RCS Cold Leg Loop D at Byron Unit 1 degraded between refueling outages B1R11 and B1R12, although the valve fully stroked on the first attempt during each outage.

In addition to the specific experience at Byron, the documents provided by the licensee indicate performance problems with RCS LSIVs at other pressurized water reactor (PWR) plants in the past. For example, Westinghouse Corporation is said to have reported valve guide failures in RCS LSIVs at Zion Unit 1 (1982), North Anna Unit 1 (1985), and Braidwood Unit 1 (1996). The licensee's information indicated that the broken valve guide from the LSIV at North Anna Unit 1 traveled to the bottom of the reactor vessel. In addition to the potential for valve guides to break and fall into the RCS flow stream, there is also a possibility (though unlikely) for the valve discs to separate from the stem following breakage of the valve guides and to inadvertently block RCS flow. Other problems with RCS LSIVs at PWR plants have occurred as a result of failure of the valve stem or separation of the valve disc from the stem.

Based on plant and industry experience, the licensee considered the performance problems with 1RC 8002C in Byron Unit 1 to be due to a valve guide shifting in the valve and preventing full travel of the valve disc. The licensee believed the shift in valve guide position to be caused by failure of the pin that is used to keep the guide properly aligned in the valve body. As the valve closes, the valve disc assembly tries to force the guides to return to their original position. If the valve guides do not return to their original position, the motor actuator will continue to produce higher torque output until the torque switch setting is exceeded and the torque switch stops the motor actuator in a mid-stroke position. Operating experience indicated that several closure attempts might be necessary to force the valve guides into their original position.

The licensee originally planned to repair 1RC 8002C in Byron Unit 1 during refueling outage B1R13 in the spring of 2005 because the 10-year inservice inspection during that outage involved removal of the lower core barrel that allowed access to the 1C cold leg nozzle. Based on the radiological exposure to plant personnel that would result from the planned valve repair and its estimated cost, the licensee decided shortly before the beginning of refueling outage B1R13 that, if 1RC 8002C operated successfully during the refueling outage, it would treat the work planned for 1RC 8002C as a contingency repair where the work will be performed in the future only if the valve completely fails to operate. In considering whether to change the valve work to a contingency repair, the licensee noted that access to 1RC 8002C during typical refueling outages would require installation of a temporary reactor vessel cover that might cause industrial safety concerns (although a new containment loading system was said to minimize those concerns). In light of the degraded condition of 1RC 8002C, the licensee planned to start Reactor Coolant Pump (RCP) 1C prior to the other reactor coolant pumps when coming out of the refueling outage at Byron Unit 1 in an effort to prevent any loose parts from 1RC 8002C being carried into RCP 1C by reverse RCS flow. The licensee also planned to

monitor RCS Loop C using the Loose Parts Monitoring System during plant restart.

III. Potential Safety Concern

In reviewing the 10 CFR 2.206 petition and the initial information provided by the licensee during telephone conferences and in its March 5, 2005, submittal, the NRC staff determined that a potential safety concern existed with respect to the performance of 1RC 8002C at Byron Unit 1 for the following reasons:

1. Multiple valve strokes continued to be necessary to close 1RC 8002C following installation of the blocks at the bottom of the valve guides in refueling outage 1BR10. For example, it required six strokes to close the valve during refueling outage B1R11, three strokes to close the valve during refueling outage B1R12, and two strokes to close the valve during refueling outage B1R13.

2. The licensee's justification for deferring the maintenance of 1RC 8002C during refueling outage B1R13 did not provide evidence of the proper installation of the valve blocks in light of the unexplained multiple strokes necessary to close 1RC 8002C.

3. The experience at Byron Unit 1 of the valve guide in 1RC 8002A slipping out of the groove in the valve body because of pin failure prior to refueling outage B1R09 demonstrated the potential for such an event. Further, loose parts monitoring indications obtained in the area of 1RC 8002A were similar to indications in the fall of 2001 near 1RC 8002C.

4. Industry experience revealed valve guide failures in LSIVs at other plants. In particular, a broken valve guide from an LSIV traveled to the reactor vessel at North Anna Unit 1 in 1980.

5. The licensee's justification for deferring the valve maintenance for 1RC 8002C did not demonstrate that Final Safety Analysis Report (FSAR) Chapter 15 analyses would continue to be satisfied if (a) the valve disc separated and rapidly stopped RCS flow if both guides failed, or (b) a large loose part from 1RC 8002C was present in the reactor vessel during an RCS hot leg loss-of-coolant accident (LOCA).

6. Several weaknesses existed in the licensee's justification for changing the maintenance that was planned to be performed on 1RC 8002C during refueling outage B1R13 to a contingency repair that might not be performed for the remaining life of the plant.

7. The licensee did not provide long-term action plans to resolve the degraded condition of 1RC 8002C in the future.

As a result, the NRC staff concluded that a more detailed review of the licensee's actions in response to the poor performance of 1RC 8002C was necessary to determine whether safety concerns existed with the restart of Byron Unit 1 from refueling outage B1R13 or with the long-term operation of the plant.

IV. NRC Staff Review

The petition filed under 10 CFR 2.206 questioned the licensee's justification for changing the maintenance planned for RCS Loop C LSIV 1RC 8002C during refueling outage B1R13 to a contingency repair. Based on the design features of 1RC 8002C, and operating experience with 1RC 8002C and other LSIVs at Byron and additional plants, the NRC staff considered the petitioner to raise a potential safety concern. Therefore, the staff evaluated whether a safety concern existed with the restart of Byron Unit 1 and whether the licensee has adequate processes in place to address the long-term performance issue with 1RC 8002C.

As part of this review, the staff requested additional information, conducted several telephone conferences, and held a public meeting with the licensee at the Region III office on March 21, 2005, to discuss the technical issues related to the structural integrity of the valve guides in 1RC 8002C, and the licensee's short-term and long-term actions to resolve the performance issues with the LSIVs at Byron station. On May 27, 2005, the licensee submitted additional information regarding 1RC 8002C in response to the May 4 request from the NRC staff. In response to weaknesses in plant documentation noted by the NRC staff during the public meeting on March 21, the licensee provided in its May 27 submittal a revision to Issue Resolution Documentation #2005-02 that strengthens its basis for changing the planned maintenance for 1RC 8002C to a contingency repair.

In evaluating whether a safety concern existed from a potential for the valve guides in 1RC 8002C at Byron Unit 1 to become misaligned and damaged during valve operation, the NRC staff reviewed the licensee's information regarding the installation of valve blocks at the bottom of guide channels in the cold leg LSIVs by robotic methods during refueling outage B1R10 (fall 2000). When properly installed, the blocks physically prevent intact valve guides from sliding out of the groove and into the RCS flow stream. In addition, the height of the valve blocks exceed the vertical tolerance of the valve guide such that an intact valve guide cannot be lifted up and over its block. At the March 21 meeting, the licensee described the welding process for the valve blocks and estimated that the welds could withstand over 5000 lbs of thrust. The licensee provided the installation package for the valve blocks and noted that quality control hold points during the welding process indicated that the blocks had been installed properly. The licensee stated that a general visual inspection of 1RC 8002C had been conducted by remote means during installation of the valve blocks. Although the licensee did not have visual records to confirm proper installation of the valve blocks, the staff considered the licensee to support its assertion that the valve blocks would prevent the guides from becoming misaligned during plant operation.

In the absence of visual records confirming the proper installation of the valve blocks in 1RC 8002C, the licensee addressed the impact if the valve guides were misaligned and struck by the valve disc during the closure stroke. During the March 21 public meeting and in its May 27 submittal, the licensee described its assessment of the structural integrity of the valve guides assuming various orientations that might occur if the valve blocks did not prevent misalignment of the guides. From its calculations, the licensee determined that the thrust output at the current torque switch setting of the motor actuator for 1RC 8002C was not sufficient to deform or endanger the structural integrity of the valve guide. The NRC staff also estimated the stress in the valve guides that could be produced if the guides were misoriented and struck by the valve disc. The staff's analysis agreed with the licensee's determination that the stress applied to the valve guides in 1RC 8002C would likely not exceed the yield stress of

the guide material at the torque switch trip setpoint.

In addition to describing its stress analysis for the valve guides in 1RC 8002C, the licensee presented photographs at the March 21 meeting of the valve guides in 1RC 8002A. The photographs showed the condition of the valve guides in 1RC 8002A after they were struck by the valve disc during a closing stroke in refueling outage B1R09 when the guides had become misaligned. The photographs of 1RC 8002A revealed no significant damage to the valve guides. The photographs were not conclusive on their own because the torque switch trip setpoint is lower for 1RC 8002A than for 1RC 8002C.

During refueling outage B1R13, the licensee removed the reactor core from Byron Unit 1 to perform a 10-year inservice inspection of the reactor vessel. During this inspection, the licensee searched the RCS for loose parts. The licensee reported that some loose parts were found and retrieved. However, the licensee stated that it had not identified any loose parts in the RCS associated with the LSIVs. In its May 27 submittal, the licensee indicated that a small piece of metal debris discussed during the March 21 public meeting did not originate from the recent LSIV degradation.

As a precaution for potential loose parts, the licensee discussed its loose parts monitoring system and RCS pump startup process in its May 27 submittal. In particular, the licensee plans to start the RCS Cold Leg Loop C reactor coolant pump prior to the other reactor coolant pumps to preclude any loose parts from 1RC 8002C being swept into that pump. The licensee plans to maintain its loose parts monitoring of the RCS during plant operation in the event of the occurrence of a loose part from 1RC 8002C or other sources. Nevertheless, the licensee discussed the consequences of loose parts from a cold leg LSIV in Byron Unit 1. The staff reviewed the licensee's submittal with regard to the likelihood, sizes, means of detection, alarms, and consequences of loose parts. The staff evaluated the potential for either a large or small part becoming loose in the primary system from 1RC 8002C.

As discussed above, there is very low potential for the valve guide to become a loose part in the Byron Unit 1 primary coolant system. However, the staff also considered if a large part typified by the valve guide were to become a loose part. In its May 27 submittal, the licensee discussed the detection and alerting system which would enable plant personnel to identify the presence of a large loose part, and the procedures to be used to identify and respond to the loose part. These procedures include the possibility that the plant would be shut down. While the discussion did not commit to specific criteria for the decision to continue to operate or shut down the plant, the staff expects that identification of a large loose part of the mass of an LSIV guide would likely necessitate shutting the plant down for repairs. Regarding the consequences of a large loose part on a design basis LOCA, the staff notes that the compounding of probabilities of the large loose part being present and the occurrence of a LOCA of sufficient size to cause the loose part to become an aggravating factor are very small. In the past, NRC regulatory positions have permitted the use of leak-before-break technology in addressing large dynamic loads on primary system components. Also, if a large break LOCA were to occur, the danger from a large loose part would be small compared to other projectiles that would be caused by the resulting dynamic loads. As stated, such events are probabilistically precluded. The staff considers that the potential for a large loose part, such as an LSIV guide, does not represent a significant impact on safety compared to other issues that have been specifically considered.

With respect to small loose parts, the staff notes that it is harder to detect their presence on a timely basis. The licensee has presented information that indicates that small loose parts would not have a significant impact on safety. The licensee also points to the Byron history of certain small loose parts that have not caused problems, including some that have not been removed from the primary system. The licensee uses the same loose parts monitoring system and procedures to address small loose parts as it uses to address large loose parts. While small loose parts detection and identification may be more difficult, small loose parts are less likely to cause an immediate safety problem than large loose parts. To identify or verify identification of small loose parts, the licensee's loose parts monitoring program includes provisions to consult its loose parts monitor system provider for interpretation of the monitor output. While this takes more time, the occurrence of small loose parts is not associated with immediate safety concerns as are large loose parts.

During consideration of the potential for loose parts from the Byron LSIVs, the staff postulated two specific situations:

1. A loose part obstructing the CVCS letdown line from the RCS, and

2. A loose part obstructing and disabling pressurizer spray.

The staff considered whether either of these situations might prevent shutting down of the plant. In its May 27 submittal, the licensee addressed these two postulated scenarios by referring to the Byron Unit 1 FSAR, Section 5.4, which discusses compliance with NRC Staff Position RSB 5-1 on cold shutdown. This FSAR section provides information to show that Byron has the capability to transition from normal operating conditions to cold shutdown under a natural circulation scenario with limited functional capability including a loss of RCS letdown and without pressurizer spray. The NRC confirmed this capability in NUREG-0786, "Safety Evaluation Report Related to the Operation of Byron Station Units 1 and 2," Supplement 2, Section 5.4.3, "Residual Heat Removal System."

During the March 21 public meeting, the licensee discussed its long-term plans for resolving the performance issues with 1RC 8002C. First, the licensee noted that the rigging structure needed to perform the repair to 1RC 8002C had been constructed during refueling outage B1R13. Second, the licensee stated that a contingency repair plan for 1RC 8002C would be prepared for the next refueling outage (B1R14) scheduled the fall of 2006 if repairs are necessary at that time. Third, the licensee is evaluating enhanced diagnostics for 1RC 8002C to be used during refueling outage B1R14. Fourth, the licensee indicated that it is preparing a formally documented decision tree with specific criteria to determine the need for repair of 1RC 8002C with the help of the valve manufacturer Westinghouse. During the public meeting, the NRC staff noted that the licensee's long-term action plan to resolve the degraded condition of 1RC 8002C should consider (a) future diagnostic testing; (b) loose parts monitoring; (c) action criteria for diagnostic test and loose parts monitoring; (d) verification of guide integrity (analysis and visual); and (e) corrective maintenance activities to resolve poor performance of all LSIVs. In its May 27 submittal, the licensee identified an action item to develop a long-term plan by September 1, 2005, to identify any additional diagnostic testing or inspection to be performed to assess valve performance during future outages. The licensee also indicated that the long-term plan would address how the loose parts monitoring system will be used in diagnosing any issue involving 1RC 8002C.

In summary, the NRC staff's review focused on whether 1RC 8002C was degraded to a point where a loose part (i.e., a piece of valve guide) could be generated and travel to the reactor vessel. As discussed in the points above, the licensee's and staff's analyses of the torque switch settings for 1RC 8002C indicated that the thrust forces were unlikely to cause yielding or breaking of the valve guides. During refueling outage B1R13, the licensee was able to fully close 1RC 8002C indicating that the valve guide had not slipped onto the valve seat. The staff's review of the length of the valve guide and its geometric relation to the valve disc when the valve is open finds that the valve guide cannot exit the valve in one piece (i.e., it must be broken into shorter pieces first). No plant that had the valve guides break into the RCS or slip onto the valve seat had retaining blocks installed such as those currently installed at Byron Unit 1. Therefore, a key issue was whether the valve blocks were still in position in 1RC 8002C. Although the licensee did not inspect the blocks this past outage, it did perform its 10-year inservice inspection of the reactor vessel with the core was removed. With this access, the licensee inspected for loose parts in the vessel and found no loose parts that may have come from the LSIV. As a result, the NRC staff finds that the Byron Unit 1 RCS Cold Leg C LSIV 1RC 8002C is unlikely to be degraded to a condition where the valve guide, or a portion of the valve guide, can come loose and be transported to the reactor vessel during normal plant operation. Nevertheless, the staff considered the potential for loose parts from 1RC 8002C being released into the RCS at Byron Unit 1.

V. Conclusion

The petitioner raised a potential safety concern regarding the performance of 1RC 8002C at Byron Unit 1 and the licensee's decision to change the planned maintenance for 1RC 8002C to a contingency repair. The NRC staff reviewed the information provided by the licensee in submittals, during telephone conferences, and during a public meeting on March 21, 2005, to determine whether a safety concern existed with the restart of Byron Unit 1 from refueling outage B1R13 in the spring of 2005 .

From its review and analysis, the NRC staff did not object to the restart of Byron Unit 1. The staff based this position on the following conclusions:

1. Analyses of the valve guides in 1RC 8002C performed by the licensee and NRC staff, as well as the minimal impact on the valve guides in 1RC 8002A when struck by the valve disc, support the assumption that the torque switch thrust for 1RC 8002C had not caused severe cracking of the valve guides if they were misaligned.

2. Installation of the blocks at the bottom of the valve guides for 1RC 8002C prevents the intact guides from falling into the RCS flow stream.

3. No LSIV loose parts were reported to have been found during refueling outage B1R13. (The licensee subsequently evaluated a small part discussed at the March 21 public meeting and determined that it was not related to recent LSIV degradation.)

4. Short-term contingency actions of the planned loose parts monitoring and the priority startup of the RCS Cold Leg Loop C reactor coolant pump were sufficient for plant restart if a loose part should occur.

In addressing whether any safety concerns exist regarding the long-term operation of Byron

Unit 1 in light of the poor performance of 1RC 8002C, the NRC staff considered the previous information provided by the licensee and the additional information in its submittal dated May 27, 2005. As discussed above, the staff concludes that the licensee adequately justified the structural integrity of the valve guides in 1RC 8002C. With respect to the licensee's loose parts monitoring system and procedures, the staff concludes that:

1. Large loose parts from the Byron Unit 1 cold leg LSIVs have an acceptably low potential to occur.

2. The licensee's loose parts monitoring provisions would detect, alarm, and help locate and identify large loose parts, including LSIV guides should they become loose parts.

3. The licensee has provisions to locate, attempt to identify, and respond to both large and small loose parts, including LSIV loose parts.

4. The licensee's compliance at Byron with NRC Staff Position RSB 5-1 assures that the two LSIV loose part scenarios postulated during this review will not prevent shutdown of the Byron units.

Although discussed during the March 21 public meeting, the licensee did not provide its long-term plans to address the poor performance of 1RC 8002C in its May 27 submittal. Instead, the licensee indicated that its long-term plans for 1RC 8002C would be prepared by September 1, 2005. The NRC staff will request that the licensee provide the long-term plans for addressing the performance of 1RC 8002C to the NRC for discussion when available.

As a generic consideration, the NRC staff plans to discuss with the Westinghouse Owners' Group the installation of valve blocks in the LSIVs at other applicable nuclear power plants and the criteria for the evaluation of loose parts in PWR plants.