UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO CONTROL ROD POSITION INSTRUMENTATION TO FACILITY OPERATING LICENSE NO. DPR-34 PUBLIC SERVICE COMPANY OF COLORADO FORT ST. VRAIN DOCKET NO. 50-267

1. INTRODUCTION

This Safety Evaluation concerns control rod position instrumentation (RPI) failures that were recognized subsequent to the partial ATWS event at Fort St. Vrain on June 23, 1984. The NRC issued an Assessment Report [Reference 1], which addressed the ATWS event and the RPI failures, and included recommended actions to be taken at Fort St. Vrain before the plant is restarted. The objective of this evaluation is to review the licensee's response regarding the following issues: the causes of the RPI failures, the methods to prevent further failures, operability and surveillance actions for the RPIs, and the adequacy of the licensee's proposed backup method for verification of rod full-in position.

The submittal by the licensee in response to the Assessment Report takes the form of a series of reports dated about January 31, 1985 [References 8-15]. Numerous additional documents were reviewed, including background information about control rod drive design and operation, supplied by General Atomic Company, NRC reports, and Public Service Company of Colorado (PSC) related submittals [1-7, 16-18]. Evaluations and conclusions are provided based on the licensee's response to questions and the information contained in the licensee's submittals.

2. BACKGROUND

On June 23, 1984, the Fort St. Vrain plant experienced a partial ATWS event, in that 6 of 37 control rod pairs failed to insert into the reactor core in response to an actual scram signal. Subsequently, on July 31, 1984, PSC reported 11 RPI anomalies to the NRC. The anomalies included improper analog and digital indications of rod position, faulty slack cable, erroneous rod full-in and full-out limit indications.

During August 1984, we visited the plant to investigate the RPI failures and related problems. We met with the licensee again at the plant site on November 28, 1984, at which time the licensee indicated the general steps that were being taken regarding the instrumentation problems. On January 31, 1985, the licensee provided documentation of its evaluations and efforts relating to restart. These documents were reviewed by the staff and its consultant, Franklin Research Center. Questions arising from the review were addressed by the licensee during a transcribed meeting at the plant site on February 22, 1985.

In order to establish the scope of this review, we have revisited the Assessment Report, the Region IV letter of January 16, 1985 to PSC, and the PSC response of January 28, 1985 [1, 13, 17]. The following restart items are within the scope of this review.

- Determination of RPI Failure Causes and Corrective Action
- Procedures for Prevention of Driving Control Rods Beyond the Full-in Limit
- RPI Limiting Conditions for Operation
- Position Instrumentation Surveillance Program

During this evaluation, we determined that revisions of the plant procedures are necessary to assure that appropriate action is taken upon indication of mispositioned rods following a scram. Additionally, during the February 22, 1985 meeting with the licensee, the Wattmeter test was reclassified as a restart issue.

3. EVALUATION

The evaluation is divided into the following sections:

Each section includes the conclusions regarding that topic.

3.1 ROD POSITION INSTRUMENTATION (RPI) FAILURES AND CORRECTIVE ACTIONS

Subsequent to the reactor trip of June 23, 1984, the licensee identified 11 control rod position instrumentation (RPI) failures. The failures included simultaneous rod full-in rod and rod full-out indications, full-out switch lights remaining lit, indications of partial rod withdrawal, no position signals, disparity between analog and digital rod position information, and a slack-cable indication. The failures caused conditions in which the operators could not determine the position of certain rods based upon the existing indicators. As described in the October 16, 1984 Assessment Report [1], for one rod pair the analog and digital RPIs indicated it to be at the 40-inch withdrawn position. Simultaneously, the full-in position indicator for this rod was not operable. When asked if the instrumentation should be believed, PSC personnel responded that it did not believe the installed RPIs, but had verified to its satisfaction that the control rod was fully inserted.

The results of the licensee's investigation into the causes of these failures and his proposed corrective actions are included in Attachment 4 of PSC letter P-85032 [12], dated January 30, 1985. This report suggests that the failure causes for both the switches and the potentiometers were primarily mechanical in nature and were not electrically induced. The licensee confirmed this general conclusion during the February 22, 1985 meeting.

Limit Switch Failures

The limit switches that indicate full-in or full-out positions are roller plunger-type microswitches. The licensee stated that the 30° slope of the cams that operate the limit switches is too abrupt, causing a high lateral force between the plunger and the shaft tube that eventually results in switch failure. This failure cause may have been compounded by increased friction due to pitting of the plunger and shaft tube from the effects of moisture.

Our evaluation of the licensee's description of the failure cause indicates that it should be expected, given the design of the limit switch. Further, the failure mechanism is consistent with our previous experience with such switches. We conclude that the failure cause identified by the licensee is credible.

The licensee proposes to change the slope of the limit switch cams to 15° to reduce the lateral force. However, these cams are not expected to be installed at the time of return to service.

During the present refurbishment of the CRDs, the operation of the switches will be checked and those switches which are not operational will be replaced in kind. The level of deterioration of the operational switches will not be evaluated. Therefore, potentially degraded but operational switches will be returned to service.

Potentiometer Failures

There are two separate failure mechanisms associated with the analog and digital position potentiometers: one relates to internal damage of the potentiometers and one relates to external damage of the associated coupling. The internal failure mechanism for the potentiometers is travel beyond the 10-1/2-turn capability. The greatest potential for such overtravel is at the full-in limit, especially if the full-in limit switches have failed. Review of the CRD design indicates that damage may result from an inward overtravel of as little as six inches. There is no mechanical stop that interrupts CRD travel before potentiometer failure might occur. The analog and digital potentiometers share a common drive shaft so that simultaneous failure may occur if both potentiometers exceed their overtravel limits. The licensee proposes to replace the 10-1/2-turn potentiometers with 15-turn potentiometers so that overtravel of the drive will not cause internal damage to the potentiometers. However, the 15-turn potentiometers are not expected to be available for installation at the time of the scheduled plant restart.

The external failure mechanism associated with the potentiometer is caused by mechanical interference between the cams for the limit switches and the multi-jaw shaft coupling on the common drive shaft for the potentiometers. During an inward overtravel, one of the limit switch cams can strike the coupling, thereby breaking the coupling. Plant experience has shown that, if this failure mode occurs, it is possible for the analog indicator to agree with the digital indicator, and for both indicators to track rod motion, but both indicators can be grossly inaccurate (i.e., offset) with respect to the actual position of the rod pair. No modifications have been proposed by the licensee to eliminate damage caused by the interference between the cam and the coupling.

Prior to startup, already-damaged potentiometers will be replaced, as will damaged multi-jaw couplings that connect the potentiometer shaft to the CRD gear train. The replacement potentiometers will be 10-1/2-turn devices, not 15-turn devices.

3.2 PREVENTION OF INWARD OVERTRAVEL OF RODS

Since modifications that prevent overtravel or otherwise preclude damage as a result of overtravel will not be in place at the time of restart, procedures must be instituted that preclude intentional inward overtravel of the control rod pairs and reduce the probability of such damage.

In Attachment 7 to PSC letter P-85040 [14], the licensee provided a revision of page 17 of 20 of Procedure SOP 12-01, that describes actions to be taken if the "in limit" light is not received when a rod is believed to be fully inserted. The previous practice had been to drive the rod further inward in search of limit switch actuation. In the revised procedure, the operator is directed to first withdraw the rod a few inches, trying to obtain the full-in position indication. The procedure then directs the operator to move the rod switches inward until rod motion automatically stops, or an indication of zero inches is attained, whichever occurs first.

Use of the revised procedure will help assure that rod position indications remain available for use. However, no direction or suggestion is given to perform a lamp test or to verify the analog/digital position indication prior to this special rod movement. It is recommended that these steps be added to this procedure.

It is also unclear that this particular procedure, SOP 12-01, governs all conditions in which manual rod inward travel in the vicinity of the full-in position may be performed. The licensee should modify all applicable procedures to similarly reduce the likelihood of inward overtravel of the rods near the full-in limit.

3.3 RPI MINIMUM PERFORMANCE REQUIREMENTS

Control rod full-in limit indications are "important to safety" because they are the primary means of verifying that all the CRDs have fulfilled their reactor scram safety function. Immediately following a plant trip, total reliance on the startup range nuclear instrumentation may be inadequate. The analog position indicators are "important to safety" because they provide the operator with continuous position information for all the rods during operation and following a scram.

In contrast, however, the digital position indicators and the full-out position indicators are not as important, but provide information that is useful for accurate position data, fine control of reactor power, and as operational conveniences. They may be used a backup indicators, in the event of a loss of the analog or full-in limit indications.

The NRC Assessment Report recommended the Technical Specification Limiting Conditions for Operation be established to define the minimum performance requirements for the RPIs.

The licensee has concluded that a specific limiting condition for operation (LCO) governing rod position instrumentation is not necessary. The basis of this conclusion is that other LCOs indirectly require instrumentation to be operable. In Attachment 1 to PSC letter P-85040 [14], the licensee discussed LCOs 4.1.2, Operable Control Rods; 4.1.4, Partially Inserted Rods; and 4.1.8, Reactivity Status that require surveillance tests that in turn require the use of position indicators. The licensee's reasoning is that lack of position indication will preclude performance of a surveillance test and therefore an LCO will not be met.

The use of indirect LCOs as a requirement for position indicator operability does not focus attention on the importance of the RPIs, does not provide definitive action statements for partial losses of instrumentation, and does not ensure timely resolution of indication failures. In addition, the use of indirect LCOs is not consistent with the Technical Specifications for other operating plants. In summary, we do not agree with the licensee's conclusions.

In light of the possibility of an ATWS event, coupled with the propensity of the position indications to fail, the following concepts related to RPIs must be implemented via procedures prior to restart and via a new Technical Specification LCO soon after restart:

> At startup and during operation, the analog rod position indicator and full-in rod limit indicator for each control rod pair shall be operable.

If an analog indicator is inoperable, operation may continue provided that one of the following conditions is met: (1) when the rod is fully inserted, the full-in limit indication is operable or the full-in position has been established by an independent means of verification; (2) when the rod is in a mid-position, rod position is continuously indicated by an operable digital position indicator and the full-in limit indicator is operable; or (3) when the rod is in the full-out position, the full-out and the full-in position limit indicators are operable.

If the full-in indicator is inoperable, operation may continue provided that one of the following conditions is met: (1) when the rod is fully inserted, the full-in position has been established by an independent means of verification; or (2) when the rod is in a mid or full-out position, both the digital and analog indicators are operable and are known to be accurate at the full-in position, and a digital indicator is continuously indicating the rod's position.

In addition to the new LCO described above, a modification to LCO 3.1.2, Operable Control Rods, is necessary. This modification must incorporate the concept that a control rod shall be considered inoperable if its associated RPI is inoperable and the action statements of the new LCO are not met.

Without such operability requirements, the operators may tend to lose faith in the position indications to the extent that actual failure of the rods to attain the full-in position may be inappropriately considered to be a faulty indication rather than a valid condition. The LCOs described above are necessary whether or not the proposed modifications are made to the indicator mechanisms. However, the LCO is particularly important for the present restart since the modifications that will reduce the failure rate of the indicators will not be in place. With the required LCO in effect at the time of restart, restraints will be placed on reactor operation to allow safe operation should position instrumentation failure occur.

3.4 RPI SURVEILLANCE REQUIREMENTS

The NRC Assessment Report recommends that the licensee establish Technical Specification Surveillance Requirements regarding the RPIs. In Attachment 5 of PSC letter P-85040 [14], the licensee outlines the proposed interim surveillance program for the control rod drives. This program includes partial verification of rod position indication operability at weekly and quarterly intervals during operation and during each refueling outage.

For fully withdrawn rods, the proposed weekly surveillance verifies the operability of the full-out limit indicators and verifies the difference between the analog and digital indications to be no more than 10 inches.

However, the program outline does not indicate that the analog and digital readings must correlate to the full-out or full-in position, nor does it state that the indicators must correctly track the rod position when the rod is exercised (i.e., partially inserted and then withdrawn).

For partially inserted rods, the weekly surveillance will verify that the analog and digital position indications are within 10 inches of each other. Again, the proposal does not state that the indicators must appropriately track rod motion.

For fully inserted rods, there is no proposed weekly surveillance, because other Technical Specification requirements apparently preclude movement of fully inserted rods during power operation.

The proposed quarterly surveillance adds one further test to the weekly surveillance. For rods in the full-out position, the operability of each of the redundant full-out limit switches will be verified. No additional quarterly surveillance is proposed for the RPIs associated with partially inserted and full-in rods.

The proposed refueling outage surveillance includes verification of the operability of each redundant full-out and full-in limit switch and comparison of the analog and digital position indications during a full travel scram of the analog and digital indications during a full travel scram of the rod. While not directly stated, it is assumed that the accuracy of the analog and digital position indicators will also be confirmed at the full-out and full-in positions during these tests.

The RPI surveillance actions proposed by the licensee are worthwhile and appropriate. However, the proposed surveillance program does not encompass all of the necessary aspects of RPI operability verification. To be consistent with the position established in Section 3.3, that the full-in limits and the analog indicators are "important to safety," appropriate surveillance actions are needed for these devices. Further, if the digital indicators are to be used as backup indications, some surveillance actions for these devices are also appropriate.

The surveillance tests proposed by the licensee do not address the need to verify operability of the full-in limit switches prior to outward movement from the full-in position. Nor do they verify the accuracy of the digital and analog position indicators at the full-in position prior to the first outward rod motion. Also, the proposed surveillance program description does not provide sufficient detail to determine if the operability of analog and digital position indicators will be evaluated for partially and fully withdrawn rods.

Since the failure mechanisms identified by the licensee for the full-in switches and potentiometers are associated with overtravel of a rod near the full-in limit, it is appropriate to verify that these position indicators are operable before or at the next outward movement of the rod from the full-in position. This suggests the need for verification test of these RPIs at each reactor start-up. Verification of the operability of the full-in limit switches and the accuracy of the analog RPIs may only be performed when the rods are full-in, as they are at or prior to start-up. Furthermore, simple verification checks at this time would have minimal adverse impact on plant operations.

The following concepts should be incorporated into the surveillance program prior to reactor restart. The surveillance requirements that result from these concepts are in addition to the surveillance actions proposed by the licensee and are necessary to assure that instrumentation is operable and reasonably accurate at reactor start-up, during operation, and at the time of a scram.

Prior to each reactor start-up, each full-in limit indicator should be verified as operating when the rod is full-in and operable by virtue of the change in the indication when the rod is withdrawn a short distance. Alternatively, rod full-in position indication operability may be similarly verified the first time during or after start-up that a rod is withdrawn from the full-in position.

Prior to each reactor start-up, or during the first outward motion of a rod, the analog position indicator should be shown to be acceptably accurate at the full-in position and be shown to respond appropriately when the rod is withdrawn a short distance. The accuracy requirement should be such that returning the rod to an "0" position as indicated by the analog RPI will not result in overtravel that could cause damage to the potentiometers and the associated coupling. The digital indication should likewise be shown to be operable and accurate at the full-in position.

During each weekly surveillance during power operation, the reasonableness of the analog RPI should be verified by comparing the change in analog indication with the direction and time duration of the rod travel. The analog and digital position indications should agree with each other within a predetermined amount. If a larger difference is observed, the licensee should, conservatively, assume that the analog indicator is the inoperable channel, unless it can be proven to be accurate and operable by another means.

The combination of the surveillance actions proposed by the licensee and the additional surveillance actions stated herein will provide the necessary assurance that the RPIs are operable and accurate.

3.5 BACKUP REACTOR SHUTDOWN PROCEDURE

At the time of a reactor scram, it is essential that the reactor operator have confidence in the control rod position indications and take conservative actions based upon those indications. Therefore, when a reactor scram occurs, the reactor operator must be able to verify that the rods are full-in or must take appropriate alternate shutdown actions.

In view of our conclusions regarding the corrective actions to prevent future RPI failures, we have determined that additional action is necessary. Plant procedures should specify that, if after a reasonable but conservative period (e.g., one hour), more than one rod pair cannot be verified as being at the full-in position, these rods must be assumed not to be fully inserted and the backup shutdown system is to be initiated. Such actions are necessary to assure adequate shutdown. Furthermore, immediately following a plant trip, total reliance on the startup nuclear channels may not be adequate. Therefore, the Fort St. Vrain procedure must be revised, as necessary, to include the following concepts:

> Following each reactor scram, each rod pair shall be verified to be at the full-in position by one of the following means:
>
> 1. the agreement of the analog position indication and the full-in position indications; or
>
> 2. the agreement of the analog and digital position indications (that were known both to be operable prior to the scram and to be accurate at the full-in position); or
>
> 3. the use of an independent rod position verification method (e.g., Wattmeter test).
>
> If more than one control rod pair cannot be verified to be fully inserted at the end of one hour, the backup reactivity control system must be initiated. Rods that were known to be fully inserted into the reactor prior to the scram may be excluded from the above considerations.

3.6 BACKUP FULL-IN POSITION VERIFICATION TEST

The NRC Assessment Report of October 16, 1984 [1], concluded that the installed RPI system may be inadequate to determine rod positions under adverse conditions. The licensee has been using the Wattmeter test as an independent verification of full-in positions. However, as a result of our review, we determined the test was too judgmental to provide convincing verification. Therefore, the licensee was requested to refine its means of verifying that the control rods are fully inserted.

The licensee's Wattmeter tests analyze the electrical power required by the motor when the control rod pair is moved a short distance in the vicinity of the full-in position. These tests were described in Attachment 6 to PSC letter P-85040 [14].

The electrical power requirements at the full-in position differ from other positions due to the unwinding of the cable from the drum. As the cable unwinds for approximately the last 10 inches, the point of connection of the cable to the drum changes from the horizontal (3 o'clock position), where the moment arm on the drum is greatest, to a vertical (6 o'clock) position where the moment arm is zero. Because of this change in moment, the power requirements for the motor in both the inward and outward directions near the full-in position are different from other positions of the rod. On an outward pull from the full-in position, the transient power peak is lower and of shorter duration than on outward pulls from other positions, and the power peak is followed by a dip in power below the steady-state level, which also does not occur at other positions. On an inward drive to the full-in position, the power rises slightly as the full-in position is reached. This rise does not occur at other positions of the rod.

The licensee has sufficiently described and demonstrated the phenomena related to the electrical power changes. The uniqueness of these phenomena provides an acceptable concept for verifying the full-in rod position.

The key areas of concern continue to be the difficulty of interpretation of the wattmeter charts and the degree to which judgment is required in order to properly interpret the results. The acceptance criteria proposed by the licensee require interpretation of graphical results at or beyond the levels of precision and resolution of good engineering practice. The wattmeter used is a 1000-watt meter coupled to a stripchart recorder. The smallest division on the chart paper is equal to 20 watts. The procedure requires interpretations of differences of 4-6 watts. The procedure also requires interpretation of the decay time of the motor starting transient. The non-standard definitions of decay time stated in the licensee's procedure could allow greatly differing interpretations of the same transient. Under the definitions, one interpretation of the decay time may be as much as twice that of another interpretation for the electrical transient.

The licensee proposes to use a wattmeter that has a 1000-watt scale and uses paper with a 500-division scale. The written procedure alternately uses watts and scale divisions almost interchangeably, such that one is not really sure whether watts or scale divisions is correct.

4.0 SUMMARY

We have evaluated information provided by the licensee regarding: (1) control rod position instrumentation (RPI) failure mechanisms and corrective actions; (2) procedures to prevent inward overtravel; (3) Technical Specifications relating to RPI operability; (4) RPI surveillance program, (5) backup reactor shutdown procedures; and (6) the backup full-in position verification (wattmeter) test. The conclusions relating to these concerns are summarized below.

The licensee has determined that the failure of the limit switches is caused by the steep slope of the limit switch cams, and that two failure causes are associated with the potentiometers. In the first, the potentiometer is forced beyond its 10-1/2 turn overtravel limit and is damaged during inward overtravel. In the second, the shaft coupling for the potentiometers is struck by a limit switch cam during inward overtravel of the rod. The licensee has proposed a modification to the limit switch cam to eliminate the limit switch failure mechanism and has proposed to use a 15-turn potentiometer to eliminate the forcing of the potentiometer beyond its internal travel limit. However, these modifications will not be implemented prior to the scheduled restart, and no modification has been proposed to address the second cause of the potentiometer failures.

The licensee has modified Procedure SOP 12-1 to preclude manual inward overtravel of rods following a reactor scram. It is not clear that this procedure covers all conditions in which manual inward motion of a control rod could occur. Therefore, the licensee should confirm that all procedures in which rod travel beyond the full-in limit could occur contain appropriate cautions and controls to reduce the likelihood of damage to potentiometers and their couplings.

Contrary to the recommendation in the NRC Assessment Report, the licensee believes that no additional limiting conditions for operation (LCO) for RPIs are necessary and proposed to rely upon indirect LCOs. The use of indirect LCOs does not provide definitive actions to be taken upon the loss of RPIs and is inconsistent with the Technical Specifications of other reactors. Therefore, the LCOs described in Section 3.3 for RPI operability are necessary.

The licensee has proposed surveillance actions for the RPIs for use during reactor operation and during refueling outages. These surveillance actions are appropriate and worthwhile. However, they do not cover verification of operability of the RPIs at each startup of the reactor. The failure mechanisms for all RPIs (except the full-out limit RPI) are associated with travel near the full-in limit. Therefore, it is appropriate to verify operability of these RPIs at the next outward motion of the rod (i.e., at startup). The combination of the licensee's proposed surveillance program and the additional surveillance stated in Section 3.4 combine to provide adequate assurance of RPI operability.

When a scram occurs, the operator must believe the rod position indicators. If multiple control rod pairs are not indicated as being full-in, the operator must take timely action to initiate the backup reactor shutdown system. The modifications to the operating procedures described in Section 3.5 will assure this action.

The wattmeter test proposed by the licensee is an adequate method of verifying the rod full-in position provided that the ease of interpretation of the data is increased and the level of reliance on judgment and interpolation is decreased through the use of a more appropriate choice of wattmeter range and recorder speed.

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2. PSC Presentation and Handout Notes from Meeting at Fort St. Vrain, November 28, 1984.

3. Letter from O. R. Lee, PSC, to E. H. Johnson, NRC Region IV, Attachments 1 and 2, Observations on Reworked Control Rod Mechanisms, August 28, 1984.

4. PSC History of Observations on 44 CRDOA, Fuel Handling Procedure Work Packet, FHPWP, August 2, 1984.

5. Memorandum from J. T. Beard, NRC, to J. Miller, NRC. Subject: Executive Summary, FSV Assessment Report, September 11, 1984.

6. Rod Control System Equipment I-9303, Operation and Maintenance Manual 93-I-1-327, E-115-265, (Rev. 3), Prepared for PSC, Unit 1, Fort St. Vrain, Colorado, Gulf General Atomic, 1979.

7. Installation, Operation, and Maintenance Manual for the Control and Orificing Assembly for the Fort St. Vrain Reactor 12-D-4-63, FCN-3849, GA-9806 (Rev.) Prepared for PSC of Colorado Fort St. Vrain Nuclear Generating Station, General Atomic, May 1977.

8. Letter from O. R. Lee, PSC, to E. H. Johnston, NRC Region IV. Subject: Comments on Index No. 3 (January 15, 1985 Meeting Minutes), January 28, 1985.

9. Letter from H. L. Brey, PSC, to E. H. Johnson, NRC Region IV. Subject: Description of CRDM Failures on January 14 and 16, 1985 (Work Reports), January 28, 1985, P-85029.

10. Letter from O. R. Lee, PSC, to E. H. Johnson, NRC Region IV. Subject: Creation of FSV Improvement Committee and Items of Consideration, January 24, 1985, P-85022.

11. Letter from D. W. Warembourg, PSC, to E. H. Johnson, NRC Region IV. Subject: Results of CRDOA Debris Analysis Test Report Attached, January 18, 1985, P-85017.

12. Letter from O. R. Lee, PSC, to E. H. Johnson, NRC Region IV. Subject: Transmittal of Technical Reports, January 30, 1985, P-85032.
Attachment 1: CRODA Mechanism Temperatures Environmental Requalification
Attachment 4: Control Rod Instrumentation
Attachment 5: Cable Anchor Welding
Attachment 6: CRDOA Moisture/Purge Flow

13. Letter from R. D. Martin, NRC Region IV to O. R. Lee, PSC. Subject: Minutes of Meeting of NRC Region IV and PSC on January 15, 1985. Commitments by PSC on Plant Upgrades, January 16, 1985.

14. Letter from PSC (author unknown) to R. Martin, NRC Revion IV. Subject: (See Attachments), January 31, 1985, P-85040.

Attachment 1: Control Rod System Operability Evaluation Report
Attachment 5: Control Rod Drive and Orificing Assembly Interim Surveillance Program
Attachment 6: Wattmeter Use to Determine Inserted Absorber String Position
Attachment 7: Page 17 of SOP 12-01, Discussion of No "In Limit" Light on Fully Inserted Rod.

15. Letter from D. W. Warembourg, PSC, to E. H. Johnson, NRC Region IV. Subject: Cover Letter for Attachment, January 31, 1985, P-85937. Attachment: PSC Report No. EE-12-0010, "Failures to Scram - Control Rod Drive and Orifice Assemblies."

16. Letter from D. W. Warembourg, PSC, to E. H. Johnson, NRC Region IV. Subject: High-Pressure Scram and Ensuring Control Rod Automatic Insertion Failures P-84227, July 23, 1984.

17. Letter from O. R. Lee, PSC, to E. H. Johnson, NRC Region IV, January 28, 1985. Subject: Response to Reference 13.

18. NRC Memorandum from J. T. Beard, ORAB, to E. Johnson, Region IV. Subject: Fort St. Vrain -- Design Weakness in Reactor Scram System, March 4, 1985.

19. Letter from J. R. Buchanan, Oak Ridge National Laboratory, to Frederick J. Hebdon, NRC, February 14, 1985.