D. Fisher

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

MAR 4 1983

MEMORANDUM FOR: James P. Knight, Assistant Director for Components and Structures Engineering
Division of Engineering

FROM: R. Wayne Houston, Assistant Director for Reactor Safety
Division of Systems Integration

SUBJECT: PROPOSED SCRAM BREAKER TEST FREQUENCIES AT SALEM UNIT 1

The purpose of this memorandum is to transmit ICSB input to the EQB SER justifying the restart of Salem Unit 1 following the events of February 22 and 25, 1983 during which both reactor trip (scram) breakers failed to open on command. The enclosed information can be used to form a basis for staff acceptance of the revised reactor trip breaker test frequencies proposed for Salem by Public Service Electric and Gas Company (PSE&G).

PSE&G has proposed to test each reactor trip breaker undervoltage coil once every 31 days by simulating a solid state protection system automatic scram signal (e.g., pressurizer high pressure). The previous test interval (required by Technical Specifications) was once every 62 days. In addition, PSE&G has proposed to test each reactor trip breaker shunt trip once every 7 days by manually energizing the coil. This is done using a pushbutton test switch at the breaker. The previous test interval (required by Technical Specifications) was once within seven days prior to each startup. During both undervoltage and shunt trip coil testing, the bypass breaker opposite the breaker under test is placed in service to avoid inadvertant reactor trips.

Enclosure 1 provides calculations of acceptable test frequencies for the reactor trip breakers based on reactor trip breaker failure rate data obtained from ICSB LER searches. The reactor protection system unavailability goal of $3x10^{-5}$ (used in both NUREG-0460 "Anticipated Transients Without Scram for Light Water Reactors,"and by the ATWS Task Force and Steering Group in the development of the proposed ATWS Rule) was used in arriving at these test frequencies. Two unavailability models are provided for your consideration. The first model treats the two series reactor trip breakers in the Westinghouse design as a single system. Thus, the test frequency obtained for this model is that at which the system must be tested to achieve a system unavailability of $3x10^{-5}$. The second model treats the reactor trip breakers independently. The fact that only one of the two breakers must function for system success is designed into the model. The test frequencies obtained from these models are 6 and 35 days, respectively. This roughly corresponds to, and therefore, tends to support the test frequencies proposed by PSE&G.

Contact:
R. Kendall, ICSB, T. Dunning, ICSB
X29451 X29457

The models used were not set up to obtain test frequencies based on the specific failure mechanism (i.e., undervoltage coil mechanism failure versus shunt ~~trip~~ coil failure). These calculations should be viewed as preliminary attempts to ascertain whether the proposed test frequencies are reasonable to the staff. To arrive at an ideal test frequency based on the history of reactor trip breaker failures would require a detailed analysis performed by reliability specialists using a more reliable data base.

In addition to the above calculations, enclosure 2 contains information which we believe should be used as the basis for acceptance of the PSE&G proposed test frequencies based on engineering judgement. Based on this information we believe that the proposed 7 day test interval for the shunt trip coil may be too frequent in that the benefits of increased system availability due to increased testing may be more than offset by the potential for not restoring the system to its normal operating mode following the test and the increased probability of system failure while testing is being performed. While a trip breaker is under test, both the other trip breaker and the bypass breaker replacing the breaker under test receive signals from a single protection system logic train. Thus during testing, a single failure in the logic portion of the protection system could prevent an automatic scram. It appears that testing the shunt trip every 7 days may be counterproductive. A detailed analyses performed by qualified personnel would have to be performed to determine this point.

In conclusion, ICSB supports the PSE&G proposed revised test frequency of once per 30 days for the undervoltage coil mechanism, but believes that a 30 day frequency for testing of the shunt trip coil is sufficient.

R. Wayne Houston, Assistant Director
for Reactor Safety
Division of Systems Integration

Enclosures:
As stated

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ENCLOSURE 1

SCRAM BREAKER TEST FREQUENCIES

MODEL 1 :

Treating the two series scram breakers at Westinghouse plants as a single system in order to achieve a test frequency based on a 3×10^{-5} unavailability (for ATWS considerations). The following formula is used:

$$U = \frac{1}{2}\lambda t$$

where:
- U = Unavailability of the system
- λ = Failure rate of the system per year
- t = Test interval in years

Selecting λ as $\frac{1}{250}$ and U as 3×10^{-5} and substituting into the above equation and solving for t yields: $t = 15 \times 10^{-3}$ years, or $\sim$ 6 days. λ was chosen based on one system failure (ATWS) in 250 Westinghouse reactor years.

In arriving at the above test interval of $\sim$ 6 days, the following should be noted:

1. The Salem event was counted as only one ATWS event (failure of the single system). Some people may consider the Salem event(s) as two system failures (ATWSs).
2. Only Westinghouse plants in the United States were considered in the number of reactor years.
3. This is a "best estimate" calculation.
4. This model may be grossly oversimplified. Time constraints did not permit a detailed analysis to be performed.

MODEL 2 :

Treating the two series scram breakers at Westinghouse plants as being totally independent in order to achieve a test frequencey based on a $3x10^{-5}$ unavailability of the system (for ATWS considerations)

$$U = \frac{1}{3}\lambda^2 t^2$$

where
- U = Unavailability of system
- λ = Failure rate for individual scram breakers per year
- t = Test interval in years

Selecting λ as 9.5×10^{-2} and U as 3×10^{-5} and substituting into the above equation and solving for t yields: $t = 9.9 \times 10^{-2}$ years, or $\sim$ 35 days. λ was chosen based on 21 individual breaker failures in 220 Westinghouse reactor years (since 1973).

In arriving at the above test interval of 35 days, the following should be noted.

1. Possible common cause contributions to the breaker failure rate were not considered.
2. The number of Westinghouse scram breaker failures is based upon data obtained from ICSB LER searches. This number is not exact (the actual number is anticipated to be slightly higher).
3. Only known breaker failures in Westinghouse plants in the United States since 1973 were considered.
4. This is a "Best Estimate" calculation.
5. This model may be grossly oversimplified. Time constraints did not permit a detailed analysis to be performed.
6. If Westinghouse breaker failure data is used, the test frequency necessary to achieve an unavailability of $3x10^{-5}$ is once every 2.5 years.

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ENCLOSURE 2

PROPOSED TEST FREQUENCY ASSESSMENT

ENCLOSURE 2

PROPOSED TEST FREQUENCY ASSESSMENT

ICSB believes that the following information should be considerd in the determination of the acceptability of the proposed test frequencies for the undervoltage and shunt trip coil mechanisms for the reactor trip breakers at Salem.

1. The shunt trip coil provides a diverse means of tripping the reactor trip breaker which is electrically independent of the undervoltage trip coil. The undervoltage coil is supplied by a 48 Vdc source and is deenergized to cause a trip whereas the shunt trip coil is supplied by a 125 Vdc source and is energized to cause a trip.

2. The shunt trip coil being an energize-to-actuate device is not "fail safe" in that a loss of power will not cause a trip. However, the shunt trip is powered from a highly reliable Class 1E battery backed source.

3. Since the shunt trip coil is an energize-to-actuate device, it is not subject to the constant heating effects that the continuously energized undervoltage coil experiences. These heating effects may contribute to the higher failure rate of the undervoltage coil mechanism.

4. The mechanical construction of the shunt trip mechanism is somewhat simpler than that of the undervoltage trip mechanism. The shunt trip does not rely on the successful operation of the complex latching mechanism which has been attributed to be the source of the majority of failures of the undervoltage trip.

5. The majority of the electrical circuit breakers used in the higher voltage electrical distribution system have dc powered energize-to-actuate shunt trip coil mechanisms. These breakers are used for manual as well as automatic trip functions for load shedding and power switching. Reliability of energize-to-actuate shunt trips in similar applications throughout the nuclear power industry has been very high as demonstrated by the lack of LERs on these devices.

6. PSE&G is revising procedures to require the operator to manually trip the reactor following indication of an automatic reactor trip. Thus, on any trip signal, diverse means will be used to trip the breakers.

7. Over 70% of the known reactor trip breaker failures were caused by undervoltage coil mechanism failures.

8. Most of the concerns relating to the events at Salem on February 22 and 25, 1983 are related to the operation of the undervoltage coil (e.g., were the undervoltage trip mechanisms properly lubricated?). During the events at Salem, the shunt trip functioned properly.

Based on the above, we conclude that the increased test frequency (from once per 62 days to once per 30 days) for the reactor trip breaker undervoltage coil mechanisms appear to be appropriate and should result in an increase in reactor protection system reliability. On the other hand, however, we do not feel that increasing the test frequency of the shunt trip coil mechanism to once every 7 days is necessary, and may be counterproductive. In our judgement, a 30 day test interval for the shunt coil may be more appropriate.

Richard A. Uderitz
Vice President -
Nuclear

Public Service Electric and Gas Company P.O. Box 236, Hancocks Bridge, NJ 08038 609 935-6010

March 8, 1983

Mr. Richard W. Starostecki, Director
Division of Project and Resident Program
Region 1
U. S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

Dear Mr. Starostecki:

REACTOR TRIP BREAKER FAILURE
NO. 1 UNIT
SALEM GENERATING STATION
DOCKET NO. 50-272

This letter supplements our letter of March 1, 1983 to the Director - Division of Licensing which provided documentation of our investigation and proposed corrective actions related to two incidents on February 22 and 25, 1983. On those occasions the Salem Unit 1 reactor trip breakers failed to open upon receipt of an automatic trip signal from the reactor protection system. In both instances, the manual trip was used to shut down the unit.

Subsequent meetings between the NRC Staff and PSE&G have resulted in requests for additional information or clarification in a number of areas. The attached report provides our position on issues related to the events of February 22 and 25, 1983.

Based upon our analysis of these events, we believe implementation of the corrective actions discussed in this letter and in our March 1, 1983 letter will preclude recurrence of these events and provide confidence that Salem Unit 1 can be safely returned to service.

Sincerely,

R. A. Uderitz

Attachment
CC: Mr. Darrell G. Eisenhut, Director
Division of Licensing, NRR

Mr. Leif J. Norrholm
NRC Senior Resident Inspector

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PSE&G POSITION ON ISSUES RELATED TO
REACTOR TRIP BREAKER FAILURES
SALEM UNIT 1
FEBRUARY 22 AND 25, 1983

1. Safety Classifications of Breakers

The Reactor Trip Breakers are a part of the Reactor Trip System which is designed to automatically trip the Reactor. The PSAR indicates that these breakers were to be designed to the criteria defined in Proposed IEEE "Standards for Nuclear Power Plant Protective Systems." The FSAR and UFSAR identify the Reactor Trip Breakers as being designed to IEEE-279-1971 "Criteria for Protection Systems for Nuclear Power Generating Stations." In addition, the FSAR and UFSAR indicate that the breakers are designed to meet the intent of IEEE-344-1971 "Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations." There has been no change in classification of this equipment since the original design of the Salem Generating Station.

2. Identification of Cause of Failure

As indicated in our letter of March 1, 1983, PSE&G has identified the cause of the failure of the Reactor Trip Breakers to be lack of proper lubrication on the undervoltage trip attachment.

3. Verification Testing

The following preoperational verification program will be completed prior to returning the trip breakers to service.

The manufacturer will electrically test each undervoltage trip attachment on a test breaker twenty-five times. After installation of the undervoltage trip attachment, the reactor trip breakers will be tested a minimum of ten times in accordance with Maintenance Procedure M3Q-2. After installation into the appropriate breaker compartment, a response time test of the breaker, actuated through the SSPS, will be performed.

4. Revised Surveillance and Maintenance Procedures

Surveillance procedures associated with the Solid State Protection System have been revised to increase the frequency of surveillance testing on the reactor trip breakers from 60 days to 30 days until further experience is gained.

The procedure for maintenance, inspection and testing of the reactor trip and bypass breaker has been issued.

PSE&G embarked on a managed maintenance program in July 1982, the purpose of which is to throughly review and update the preventative maintenance program for certain components and systems. For these components and systems, all existing maintenance procedures will be reviewed and revised if necessary.

5. Operating Procedures

The procedure used for Reactor Trips has been revised to direct the operators to immediately initiate a manual reactor trip whenever there is a Reactor Trip demand indication present on the overhead annunciator or reactor protection status panel. The procedure has also been modified to provide additional steps for dealing with failure of the reactor trip breakers to open.

6. Training Effectiveness

While we believe that our operators had an adequate understanding of the Solid State Protection System and reacted properly, additional training will be conducted prior to startup to re-emphasize and strengthen their understanding of the Solid State Protection System and the significance of associated alarms and indicators. This training will be in addition to the regular requalification training program which will also emphasize these subjects.

7. Master Equipment List

Prior to restarting Salem Unit No. 1, appropriate personnel will be indoctrinated in the purpose and use of the Master Equipment List (MEL). The copies of the MEL currently in use for maintenance and procurement will be reviewed to ensure that each set is complete.

In addition, a program has been undertaken to review and reissue the MEL. This program will include a detailed review of the MEL data to determine completeness and to validate the classification of data contained therein. Any errors or omissions will be corrected. Following validation, the MEL will be reissued as a controlled document with instructions on its purpose and use. Instructions will also be issued to users of the MEL to redefine the mechanism for obtaining classification for any items not included in the MEL. Also, a procedure will be developed to provide instructions on updating the MEL and the frequency of the updating.

This effort will be completed by May, 1983.

8. Maintenance Work Orders

The administrative procedure for the control of Station Maintenance will be revised to include a Quality Assurance review of all Work Orders designated non-safety related prior to performing the work to ensure proper classification. Indoctrination of appropriate personnel in the use of the procedure will be conducted prior to startup.

9. Timeliness of 50.72 Reporting

The importance of adhering to the reporting requirements of 10 CFR 50.72 is being reemphasized to operating personnel. In addition, the procedures, personnel training and communication systems are being reviewed and modified to assure that notifications are made within the required time periods.

10. Post-Trip Review

A formalized Post-Reactor Trip/Safety Injection review procedure has been established. The procedure establishes requirements and criteria that must be met prior to startup. The procedure also establishes personnel responsibilities, identifies the review process, and identifies the documents and records to be examined. The procedure additionally specifies the approval requirements and the authorization that is necessary prior to startup.

11. Vendor Supplied Information

Copies of all previously issued Westinghouse NSID (NSD) Technical Bulletins and NSID (NSD) Data Letters have been obtained on a controlled copy basis from Westinghouse. A review will be made to ensure that applicable documents are incorporated into station procedures where appropriate by July 1, 1983. Future issues of these documents will be reviewed by engineering and formally issued to the Station.

A review will be made to determine that PSE&G has controlled vendor manuals for all major safety system equipment, and to request such manuals from the vendors where necessary. In addition, a review will be performed to ensure that all vendor manuals in use are incorporated under a controlled system.

12. Quality Assurance

Through a recent reorganization, all personnel in the Operational Quality Assurance Organization are in the process of being relocated to the site. This change will result in increased involvement by Quality Assurance personnel in the functions of the Nuclear Department. Greater emphasis will be placed on verification of Quality Assurance program implementation through increased observation and monitoring.

13. Post-Maintenance Testing

The station procedures that establish requirements to ensure safety related equipment is tested prior to its return to service after maintenance and/or surveillance activities are being reviewed and revised as necessary to ensure adequate emphasis on quality assurance, test/retest and interdepartmental communication requirements.

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

MAR 9 1983

Docket No 50-272

MEMORANDUR FOR: Steven A. Varga, Chief, Operating Reactors Branch No. 1, DL

FROM: Donald C. Fischer, Project Manager, Operating Reactors Branch No. 1, DL

SUBJECT: INTERIM DRAFT SALEM RESTART REPORT

By copy of this memorandum the enclosed Interim Draft Salem Restart Report dated March 9, 1983 is forwarded to the NRC PDR and the Local PDR.

Donald C. Fischer, Project Manager
Operating Reactors Branch No. 1
Division of Licensing

Enclosure:
As stated

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Contents

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Abstract

A report for assuring the readiness of Unit 1 of the Salem Nuclear Generating Station for restart is presented based on the NRC evaluation of the events of February 22 and 25, 1983, when there were failures of the automatic reactor trip system following receipt of valid signals from the Reactor Protection System. The manual trip system was used to shut down the reactor. It was determined that the failures to automatically trip were caused by malfunction of the undervoltage trip attachments in both reactor-trip circuit breakers.

A number of issues have been identified as having contributed to causing the events. Short-term actions have been identified to resolve them prior to resumption of operation, as well as long-term actions needed following restart. The issues are categorized as "equipment issues" and "management issues." The equipment issues are (1) the safety classification of the circuit breakers, (2) verification testing of operability, and (3) maintenance and surveillance procedures. The management issues are (1) operating procedures, training, and response; (2) post-trip review of failure of the automatic system; (3) the quality assurance and work order procedures; (4) timeliness of reporting; (5) updating vendor-supplied documentation; and (6) post-maintenance equipment operability testing. The staff has reviewed the proposed corrective actions and has determined that they are appropriate and acceptable.

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Salem Restart Report

I. Purpose and Scope

This report briefly describes the NRC actions to address and resolve equipment and management issues identified by the NRC evaluation of the two events at Unit 1 of the Salem Nuclear Generating Station that resulted in failure of the reactor to trip automatically upon a valid signal. The second event occurred on February 25, 1983 and led to the realization that a similar event had occurred on February 22, 1983. Based upon NRC evaluation, the cause of the failure has been identified and is attributable to the lack of proper attention given to a device in the breaker assembly. Replacement of such devices with new ones and conducting proper tests and surveillances, in conjunction with resolution of related issues, provides reasonable assurance that Salem Unit 1 can be restarted.

An NRC task force has been established to conduct a separate longer range study of the broader implications of the events. NRC long-term actions noted herein are those related only to Salem. The NRC task force will determine generic actions needed for other facilities. For the Salem facility, longer term actions developed by this task force may supersede or complement some of the long-term actions identified herein.

II. Background

On February 25, 1983 an event occurred at Unit 1 of the Salem Nuclear Generating Station when the reactor-trip circuit breakers failed to automatically open following receipt of a valid trip signal from the Reactor Protection System (RPS). The manual trip system was used to shut down the reactor. Subsequently, it was concluded by the licensee that the failure to trip was caused by a malfunction of the undervoltage (UV) trip attachments in both reactor-trip circuit breakers. These UV trip attachments translate the electrical signal from the RPS to a mechanical action that opens the circuit breaker.

On February 26, 1983, an NRC team was onsite to conduct initial followup and to collect preliminary information. As a result of NRC inquiries, the licensee determined that both reactor-trip circuit breakers had similarly failed to open upon receipt of a valid trip signal on February 22, 1983. The failure to automatically trip on February 22 was not recognized by the licensee until the computer printout of the sequence of events was reexamined in more detail on February 26. Further evaluation of these events and the circumstances leading up to them revealed a number of issues that require resolution by the licensee and/or the NRC. This report identifies those issues and the short-term actions proposed to resolve them prior to resumption of operation at Salem Unit 1* and the long-term actions that are needed on a defined schedule following restart. The short-term actions required for Unit 1 will also be implemented on Unit 2 prior to restart of Unit 2.

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*Salem Unit 2 is presently shut down for refueling and is not presently scheduled to resume operation before Unit 1.

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The licensee met with NRC staff on February 28 and March 5, 1983 to present the results of initial evaluations related to the events. Based on licensee submittals of March 1 and March 8, 1983 and on the findings of the NRC evaluation of the Salem events, the issues are categorized as equipment issues and management issues. They are discussed in detail in Section III of this report.

III. Issues

A. Equipment Issues

Three of the issues relate to the affected equipment, that is, the reactor-trip circuit breakers (Westinghouse DB-50 circuit breakers). These issues are 1) safety classification of the circuit breakers, 2) identification of the cause of the failure, and 3) verification testing of the circuit breakers.

1. Safety Classification of Breakers

During the initial NRC evaluation of the February 25 event, it was determined that maintenance was conducted on the Salem Unit 1 reactor-trip circuit breakers in January 1983, following a failure of one reactor-trip circuit breaker to trip upon receipt of an RPS signal at Salem Unit 2 on January 6, 1983. The work orders authorizing the January 1983 maintenance identified the maintenance as not safety related and not requiring quality assurance review. The reactor-trip circuit breakers contain both a UV trip attachment and a shunt trip attachment, but only the UV trip attachment is operated by an RPS trip signal. As a result, it was not clear on February 26, 1983 what portion, if any, of the reactor-trip circuit breakers was considered safety related by the licensee.

Action/Evaluation

This issue has been resolved. Section 7.2.1.1 of the Salem Updated Final Safety Analysis Report (UFSAR), Revision 0, indicates that the Reactor Trip System includes the reactor-trip circuit breakers and the UV trip attachment. The Westinghouse Solid State Logic Protection System Description (WCAP-7488L) also defines the scope of the system as including the reactor-trip circuit breakers and the UV trip attachments. The UV trip attachment and the reactor-trip circuit breaker are safety-related equipment in that they are essential features of the Reactor Trip System, which is necessary to prevent or mitigate the consequences of a design-basis event that could result in exceeding the offsite exposure guidelines set forth in 10 CFR Part 100. The shunt trip attachment of the reactor-trip circuit breakers is not required by present NRC regulations and, although it is provided to perform the manual trip function, no credit is taken for this design feature in the safety analysis (a manual reactor trip also actuates the UV trip attachment). The licensee in a March 1, 1983 letter to NRC concurred in this understanding. Hence, the specific issue with regard to the safety classification of the reactor-trip circuit breakers is considered resolved. Other issues concerning the manner in which the reactor-trip circuit breakers were treated from a procurement and maintenance standpoint at Salem are addressed under Management issues (Section III B). The licensee has made a commitment to install new UV trip attachments on all four Unit 1 circuit breakers prior to restart and to verify that the new circuit breakers have been properly serviced and tested.

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2. Identification of Cause of Failure

The licensee's initial determination of the cause of the failure of the reactor-trip circuit breakers (as documented in a March 1, 1983 letter) was that there was binding and excessive friction of the vertical latch lever of the UV trip attachment due to a lack of proper lubrication. This conclusion was concurred in by Westinghouse representatives and was based on visual inspection of the UV trip attachment, in-place testing performed after the failures, and previous Westinghouse experience. Because of the importance of the reactor-trip circuit breakers and UV trip attachments, however, the NRC staff has prepared a more structured approach to resolving this item.

The NRC has conducted an initial determination of the cause of the failure based on inspection of the failed trip attachments and interviews with cognizant maintenance personnel on how the devices were maintained. The inspection indicates that there were possibly multiple contributing causes of failure. Possible contributors are (1) dust and dirt; (2) lack of lubrication; (3) wear; (4) more frequent operation than intended by design; (5) corrosion from improper lubrication in January 1983; and (6) nicking of latch surfaces caused by vibration from repeated operation of the breaker. The contributors appear to be cumulative, with no one main cause. The initial investigation indicates that the failure was age related and that a new device would perform properly. Many surfaces of the latch mechanism are worn and the additional friction tended to prevent proper operation. Proper lubrication throughout the life of the device might have prevented the wear that can be seen on the sample.

These initial findings confirm that the UV trip attachment failed from binding and excessive friction. A laboratory testing and examination program will attempt to determine the precise cause of failure, if possible. Appendix A describes the NRC inspection effort and extent of additional examination and testing to be done by NRC.

NRC Action - Short Term

NRC conducted an initial investigation of the cause of the UV trip attachment failures by visual examination of the devices by qualified personnel and determined how the devices were maintained (See Appendix A).

NRC Action - Long Term

NRC will conduct laboratory testing and examination of the failed attachments to determine the precise cause of failure, if possible. Test and examination results will be used as a basis for future maintenance surveillance and/or requirements for the UV trip attachments.

3. Verification Testing

On August 20, 1982, one reactor-trip circuit breaker on Unit 2 failed to operate during surveillance testing. A UV trip attachment was replaced on this circuit breaker, the circuit breaker was reinstalled, and subsequent post maintenance testing established operability. Similarly, on January 6, 1983, a reactor trip occurred at Salem Unit 2 due to a low-low steam generator level, but one

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reactor-trip circuit breaker failed to open. The licensee concluded that the circuit breaker failure was due to binding from dirt and corrosion in the UV trip attachment. The UV trip attachment on the Unit 2 circuit breaker, as well as the UV trip attachment on all Unit 1 reactor-trip circuit breakers, was cleaned, lubricated and readjusted under supervision of a Westinghouse representative. Since the circuit breakers again failed on February 22 and 25, adequacy of the verification testing to ensure circuit breaker operability is an issue. Verification testing following reactor-trip circuit breaker maintenance or initial installation should be sufficiently comprehensive to provide reasonable assurance that the circuit breaker will function as needed.

Licensee Action - Short Term

The licensee has proposed a program to verify proper operation of the reactor-trip circuit breakers prior to returning them to service. The program will involve preinstallation testing of UV trip attachments 25 times by the vendor. After installation on the trip breakers, the UV trip attachment and trip breaker will be tested ten more times. Following this testing, a time response test of the breaker actuated through the RPS will be performed. This issue is sufficiently resolved to permit restart of the plant pending a commitment to develop and implement a program comparable to that described under Long Term.

Licensee Action - Long Term

Although the licensee has not yet proposed a long-term program, the NRC staff proposes an extensive bench test of a reactor-trip circuit breaker and UV and shunt trip attachments as an integrated unit. The test is to involve cycling (a total of 2000 cycles) under simulated environmental service conditions to determine if a properly maintained circuit breaker and its attachments can operate for an extended number of cycles. The testing should be performed by the licensee or appropriate industry owners group or vendor.

NRC Action - Short Term

NRC will verify satisfactory completion of the licensee's short-term preoperational testing program.

NRC Action - Long Term

NRC will review the licensee's long-term operational verification program for the reactor-trip circuit breakers to assure that the following points are included:

1. a sufficient number of cycles is included to provide statistically meaningful results.

2. the test exercises both UV and shunt trip attachments (not simultaneously), as well as the circuit breakers.

3. the test is conducted under environmental conditions similar to those seen by the circuit breakers.

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4. sufficient delay time is included between cycles to allow return to steady-state conditions.

4. Maintenance and Surveillance Procedures

During the investigation, it was determined that no specific maintenance procedure existed to conduct preventive or corrective maintenance on the reactor-trip circuit breakers. The maintenance conducted in January 1983 was not performed in accordance with the latest Westinghouse recommendations, which were contained in Westinghouse Technical Bulletin NSD-74-1, as amended by technical data letter NSD-74-2. Additionally, no program of preventive maintenance had been conducted on these circuit breakers since original installation.

With respect to surveillance testing, the licensee conducted a functional test of one of the two reactor-trip circuit breakers every month, so each circuit breaker was tested once every two months. The surveillance tests, which involved tripping a circuit breaker by use of the UV trip attachment, met the technical specification requirements. The licensee also operated the circuit breakers weekly by exercising the shunt trip attachment. In view of the number of reactor-trip circuit breaker failures at Salem, it appears that the periodic surveillance testing was ineffective in assuring reactor-trip circuit breaker operability.

The licensee has now developed a maintenance procedure and preoperational verification program. The NRC staff initial review of the procedures and program identified certain deficiencies (see Appendix B). This issue is unresolved pending further review.

Licensee Action - Short Term

The licensee has now developed a specific preventive maintenance procedure for use on the reactor-trip circuit breakers (including the UV trip attachment), which is based on all applicable vendor maintenance recommendations, appropriate quality assurance (QA) requirements, and post maintenance testing.

The licensee has proposed monthly testing of the main reactor-trip circuit breakers by use of the UV trip attachment and weekly testing of the reactor-trip circuit breakers by use of the shunt trip attachment.

Licensee Action - Long Term

The NRC intends to require that the licensee incorporate results of a long-term verification testing of the reactor-trip circuit breaker into maintenance and surveillance programs.

In July 1982, the licensee had embarked on a managed maintenance program to thoroughly review and update the preventive maintenance program for certain systems and components. The licensee should continue this program and complete it in a timely manner.

NRC Action - Short Term

The NRC staff has completed an initial review of the surveillance and maintenance program and its procedures. Certain deficiencies have been identified

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(see Appendix B). The licensee will be required to complete action necessary to resolve the identified deficiencies prior to restart.

With regard to the licensee's managed maintenance program described above, the NRC staff will verify prior to restart that the licensee's program also includes the reactor trip system, emergency core cooling systems (including activation systems) actuation systems, the auxiliary feedwater system, and containment isolation systems.

The licensee's proposed surveillance test requirements on the circuit breakers will also be reviewed.

NRC Action - Long Term

NRC will evaluate the licensee's proposed lubrication requirements for the UV trip attachments (i.e., type of lubricant, frequency of lubrication, points of application, etc.). NRC will also assure that results of long-term verification testing of the reactor-trip circuit breakers are adequately incorporated into maintenance and surveillance programs to determine testing frequency, inspection requirements, and lifetimes.

The evaluations will be conducted with the assistance of the Franklin Research Center (FRC) and the Brookhaven National Laboratory (BNL).

B. Management Issues

Based on examination of the circumstances associated with the events involving reactor-trip circuit breakers, certain issues have been identified relative to procedures, training, etc. that are not solely related to the reactor-trip circuit breakers. The extent to which such issues impact other systems, components or operations at the Salem facility needs to be examined. These are categorized as management issues. They are

1. Operating procedures for ATWS and reactor trips
2. Operator response
3. Operator training effectiveness relative to the RPS and associated indicators
4. Post-trip review
5. Issues related to the Master Equipment List associated with the licensee's QA program
6. Work order procedures
7. Timeliness of 10 CFR 50.72 reporting
8. Updating vendor-supplied documentation
9. Involvement of QA with other station departments
10. Post maintenance equipment operability testing

These issues are discussed in the sections below.

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1. Operating Procedure for Anticipated Transients Without Scram (ATWS) and Reactor Trips

Interviews with control room operators were conducted by NRC staff, and a review of the operating procedure for ATWS and reactor trip (EI-4.3) have revealed that a) the operators do not take immediate action to initiate a manual trip based on reactor-trip "first-out" annunciators, b) they were not directed to do so by the procedure; however, the procedure did require a manual trip if an automatic reactor trip did not occur. The procedure required only evaluation of reactor power level remaining high and/or multiple control rods failing to insert, c) at least one operator questioned the appropriateness of the ATWS procedure's step to trip the turbine, without first verifying that the reactor had tripped, since that results in a loss of heat sink, and d) the revised procedure dated March 4, 1983, would not have substantially changed the operators' response due to a perceived need to evaluate plant status from control room indications.

Licensee Action - Short Term

1. The licensee shall identify the indications in the control room that provide positive indication, without operator analysis or verification, that an automatic reactor trip demand is present.
2. The licensee must revise procedures to direct the operators to insert a manual trip whenever positive indication of an automatic trip demand is present without delaying to evaluate the overall plant status.
3. The licensee must review the basis for the ATWS procedure steps and order of priority in light of the operators' concern, revise the procedure as necessary, and brief the operators on the basis for the procedural steps and importance of procedural compliance.
4. All operators must be trained on the revised procedures prior to restart of Unit 1.

Licensee Action - Long Term

Incorporate any procedural changes for Unit 1 into Unit 2 procedures and retrain Unit 2 operators on revised procedures prior to Unit 2 restart.

NRC Action - Short Term

NRC will review the licensee's revised procedures and basis for the procedural steps and order of priority.

NRC Action - Long Term

NRC will incorporate review of ATWS basis into the review of the Westinghouse Owners Group, Emergency Operating Procedure Guidelines review.

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2. Operator Response

Interviews with operators on shift for the February 22 and 25, 1983 events and with I&C and maintenance personnel disclosed the following:

a. In both events, the operators took 20 to 30 seconds to determine the overall plant status and initiate a manual reactor trip. For the first event, this evaluation time was necessary because of the large number of alarms and equipment and indicators lost with the electrical bus transfer failure and was nearly identical to the time it took for the plant conditions to degrad causing the RPS to respond. For the second event, the evaluation of the plant status began when the reactor trip annunciator actuated and the evaluation determined that a reactor trip was in fact necessary based on plant parameters and RPS indicators. This time could have been shortened had the operators recognized that a valid trip was called for by the RPS.

b. Information provided in the control room (i.e., first out panel alarms, illuminated RPS displays, and safety grade instruments) is adequate to immediately identify an ATWS event. I&E and maintenance personnal indicated that the first out panel and the RPS logic are highly reliable.

c. During the first event, after an operator was directed to manually trip (scram) the reactor, the switch handle was not operated correctly. When the SRO called for a manual trip, the control inadvertently was pulled off the board and had to be reinserted to perform the manual trip. Because of the near coincident automatic trip signal, this may have contributed to the operator's failure to recognize that the automatic trip system had called for a trip and had failed to trip the reactor prior to the manual trip.

d. In spite of the positive indication of the reactor protection system failure during the second event, the operators did not understand or trust the indications. Because of this the operators unnecessarily reevaluated plant status. The operators manually tripped the reactor in response to their evaluation of the plant status and RPS indicators and not due to recognition of the failure of the reactor protection system.

The NRC staff concluded that, given the operators' understanding of the reactor protection system, their lack of confidence in the annunciators, their perceived need to determine the overall plant status, and their use of procedures, the response of the operators was prompt and adequate to protect the reactor for both events.

Licensee Action - Short Term

1. Operators must be cautioned on the use of the manual trip "J" handle control.

Licensee Action - Long Term

1. The licensee should evaluate alternative means to permanently secure the "J" handle.

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3. Operator Training

Interviews conducted by NRC with the licensed operators who were onshift during the two events indicate a lack of familiarity with the functions of the annunicators and indicators associated with RPS. The interviews also revealed that the operators who were onshift during the February 25 event did not recognize that a malfunction of the RPS had occurred until approximately 30 minutes after the event. Specifically, the operators interviewed were not able to describe whether the reactor-trip-indicator light (red) on the RPS mimic status panel indicated a demand or confirmation of a breaker trip. Interviews also indicated that at least some operators questioned the validity of annunciators until they could be confirmed by independent indication. Based on a review of calibration testing incidents in 1982, where the reactor trip annunicator was actuated by a signal but no reactor trip occurred, there may be instances that operators need to verify reactor trip annunciators. This need to verify caused the operators not to take immediate action to trip the reactor based on annunicator indication alone on February 25, 1983 as discussed in management issues 1 and 2.

Testing conducted by the licensee in response to NRC questioning confirmed that short-duration signals (less than 10 milliseconds) could produce a reactor trip annunication without tripping the reactor. Initial followup of review of this testing indicates that the system is functioning as designed, requiring trip signals of more than 10 to 12 milliseconds to actuate the reactor-trip circuit breakers.

In any event, it is apparent that training in the areas of the RPS and associated indications and alarms is warranted.

This issue is unresolved pending further review.

Licensee Action - Short Term

The licensee will conduct additional training on the RPS and associated indications and alarms (specifically whether these are demand or confirmatory and the use of this information), and to review the February 22 and 25 events with all operators.

Licensee Action - Long Term

The licensee will assure that RPS training and associated subjects in the operator qualification and requalification program address the areas of (1) logical function of the RPS and (2) operation of the RPS and associated indications.

NRC Action - Short Term

NRC will evaluate the adequacy and completion of remedial training prior to Unit 1 and Unit 2 restart.

NRC Action-Long Term

NRC staff will audit the licensee's requalification program.

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4. Post-Trip Review

The licensee did not determine that there had been a failure to trip on February 22 until the computer printout of the sequence of events was reevaluated on February 26, as a result of NRC inquiries. Although the licensee conducted a review of each trip, there was no formal procedure for conducting a systematic review. By letter dated March 1, 1983, the licensee made a commitment to develop a post trip and safety injection review procedure. The procedure will specify the review and documentation necessary to determine the cause of the event and whether equipment functioned as designed. Other key elements of a post-trip review procedure are 1) necessary management authorization for restart, 2) debriefing of affected operators, 3) verification that reporting requirements were completed, and 4) followup review by safety committees.

Licensee Action - Short Term

The licensee will develop and issue post-trip and post-safety-injection review procedures and train all Operations Department personnel on the requirements prior to Unit 1 restart.

Licensee Action - Long Term

The licensee will evaluate the effectiveness of the above procedure.

NRC Action - Short Term

NRC will review the licensee's post-trip and safety injection procedures.

5. Master Equipment List

The licensee maintains a Q list that identifies activities, structures, components, and systems to which the Operational Quality Assurance (QA) Program applies. A Master Equipment List (MEL) is used by the licensee as the source document for determining the safety classification of individual equipment. The MEL is intended to be a comprehensive list of all station equipment and identifies each item as nonsafety related or safety related. When preparing maintenance work orders, the MEL is consulted to determine if QA coverage of the work is necessary. Licensee and NRC review identified three problems associated with the MEL. These problems are, 1) the accuracy and completeness of the document, 2) issuance as a noncontrolled document, and 3) lack of understanding of its proper use.

The MEL was derived from a construction program document called Project Directive 7 (PD-7) and was provided to station personnel by the Engineering Department as a reference document in July 1981. Prior to issuance of the MEL, the PD-7 was used as the reference document. The MEL, however, was not issued as a controlled document, therefore verification of its accuracy and completeness on issuance was not assured, and it was not updated in the plant as necessary. The reactor-trip circuit breakers and the RPS were not included in the MEL. In addition, some personnel were not familiar with how to use the MEL for determining the classification of a particular piece of equipment. Maintenance personnel acknowledged that reference was made to PD-7 on occasion during the January - February 1983 period.

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Licensee Action - Short Term

1. Verify the MEL is complete and accurate with respect to emergency core cooling (ECCS), including actuation systems, RPS, auxiliary feedwater, and containment isolation systems.

2. Indoctrinate appropriate personnel in the purpose and use of the MEL.

Licensee Action - Long Term

The licensee will verify the completeness and accuracy of the MEL and reissue it as a controlled document.

NRC Action - Short Term

NRC will perform sampling review of the MEL on the above systems.

NRC Action - Long Term

NRC will confirm completion of the licensee's long-term action.

6. Work Order Procedures

The review identified that the personnel preparing maintenance work orders were not complying with instructions contained in the station administrative procedures. Specifically, for the work performed on the reactor-trip circuit breaker in January 1983, the engineering department was not consulted to verify safety classification, and an erroneous nonsafety determination was made. Such consultation is required if equipment is not listed in the MEL. There was, therefore, no independent review within the maintenance organization, and the Quality Assurance Department was not involved in the work. Historically, there was no requirement for QA personnel to be involved in the review of work orders as they were processed to assure that appropriate steps were taken to assign classification.

Licensee Action - Short Term

The licensee has made a commitment to have the QA Department review all non-safety related work requirements prior to starting work, and to implement a program and training to ensure that work orders are properly classified.

Licensee Action - Long Term

The licensee will review work orders written since issuance of the MEL for proper classification and will evaluate safety consequences of those found improperly classified.

NRC Action - Short Term

NRC will review licensee's work order classification program.

7. Timeliness of Event Notification

On three occasions between January 30 and February 25, 1983, the licensee notified NRC of significant events belatedly. In each case, the notification was approximately 30 minutes late. Two of these reports were for the February 22 and 25 events. Furthermore, in the February 22 event, the first notification did not contain known significant information regarding actuation of engineered safety features and opening of the power operated relief valves.

This additional information was provided approximately 40 minutes later. The notification procedure used by the licensee warrants further evaluation as to the priority assigned for NRC notification.

Licensee Action - Short Term

The licensee will reemphasize reporting requirements with all shift and on-call management personnel and will reevaluate notification priorities.

NRC Action

NRC will confirm that licensee's short-term action is completed.

8. Updating Vendor Supplied Information

As a result of the February 25, 1983 event and NRC IE Bulletin 83-01, the licensee indicated not being aware of the existence of two Westinghouse technical service bulletins that provided preventive maintenance recommendations for the reactor-trip circuit breakers. The two documents in question were published by Westinghouse in 1974. The licensee has requested documentation for all Westinghouse equipment and will incorporate this information into station documents. An NRC staff concern is whether a similar situation exists with respect to documentation for other vendor-supplied safety-related equipment and how the licensee will maintain vendor-supplied information current in the future.

Licensee Action - Short Term

The licensee has made a commitment to a program to update existing documentation on safety equipment and to ensure that vendor documentation is under a controlled system.

Licensee Action - Long Term

The licensee will complete the above program in a timely manner.

NRC Action - Long Term

NRC will perform inspections to verify the implementation of licensee's program.

9. Involvement of QA Personnel With Other Station Departments

The Quality Assurance Department did not review maintenance work orders associated with repair of the reactor-trip circuit breakers in January 1983 because the work was not designated safety related. Further examination determined that the QA Department does not review for proper determination of classification the work orders designated nonsafety related by other departments. Discussions with the licensee indicate that the QA Department has been somewhat isolated from the activities of other departments.

As a result of prior decisions, the licensee had initiated steps in January 1983 to relocate the QA Department from the corporate offices in Newark, N.J. to the site and is taking steps to increase QA Department involvement in other station activities.

Licensee Action - Short Term

The licensee has made a commitment to institute a program to more fully integrate QA activities into the overall activities.

Licensee Action - Long Term

The licensee will complete the above QA integration program.

NRC Action - Long Term

Monitor licensee's implementation of the above QA integration program.

10. Post-Maintenance Operability Testing

Past practice at Salem for post maintenance operability testing has varied. Such testing may be specified by the preparer of the maintenance work order or left to the discretion of maintenance personnel. For safety-related equipment, generally, post-maintenance surveillance testing is done before returning the equipment to service. Additional functional post-maintenance and repair testing of equipment, such as surveillance testing, may need to be performed to demonstrate operability as an integral part of the larger component or system in which it must function.

Licensee Action - Long Term

The licensee will review and revise procedures and practices as necessary to ensure that functional testing of the overall components or system is performed to demonstrate operability prior to returning the equipment to service following maintenance and repair. Measures will be revised, as necessary, to assure that operations department personnel review the testing prior to returning such equipment to service.

NRC Action - Long Term

NRC will review licensee's revised procedures and their implementation to assure that appropriate postmaintenance operability testing is being accomplished before equipment is returned to service.

IV. Conclusions

The issues discussed in this report were developed from examination of the information revealed during numerous interviews, document reviews, and meetings

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conducted by NRC staff and contractor personnel with licensee representatives. Based upon the staff's conclusion that the cause of the failures is attributed to the failure of the UV trip attachment to automatically trip the reactor and deficiencies in its maintenance and care, restart of Unit 1 should be permitted subject to the following:

1. Replacement and operational verification of the UV trip attachments;

2. Modification and implementation of procedures associated with operator response to RPS trip signals; and,

3. Satisfactory resolution of those other issues identified as "short-term" in this report. "Long-term" issues involve more comprehensive action that do not have an immediate safety implication; furthermore, these long-term issues will be reconsidered in light of the results of the generic evaluations being conducted by an NRC Task Force. In the interim the staff intends to establish commitments for corrective actions and implementation schedule, and intends to assume timely implementation of these at the Salem facility.

The staff also believes that the long-term corrective actions related to the management issues at the Salem facility can be further evaluated as to completeness and applicability by an independent and more in-depth assessment. Accordingly, the Office of Inspection and Enforcement is planning to perform a Performance Appraisal Team (PAT) inspection of the licensee within the next few months.

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Appendix A

RESULTS OF NRC STAFF INVESTIGATION OF EVENTS AT SALEM NUCLEAR GENERATING STATION

I. IDENTIFICATION OF CAUSE OF FAILURE

Summary and Initial Findings

Initial inspection of the UV trip attachment indicates a possiblity of multiple contributing causes of failure. Possible contributors are (1) dust and dirt; (2) lack of lubrication; (3) wear; (4) more frequent operation than intended by design; (5) corrosion from improper lubrication in January 1983; and (6) nicking of latch surfaces caused by vibration from repeated operation of the breaker. The contributors appear to be cumulative, with no one main cause. The initial investigation indicates that the failure was age related and that a new device would perform properly. Many surfaces of the latch mechanism are worn and the additional friction tended to prevent proper operation. Proper lubrication throughout the life of the device might have prevented the wear that can be seen on the sample.

The tests and examinations proposed by the staff and its contractor will attempt to determine the cause of failure and if possible reproduce it. The following summarizes the initial findings and lists the proposed tests.

Discussion and Circumstances

A site visit was conducted on March 3, 1983 by NRC and Franklin Research Center personnel to inspect the type DB-50 circuit breaker undervoltage trip attachement in an effort to determine the most probable cause of failure. The reactor trip circuit breaker rooms for Units 1 and 2, each of which contain four DB-50 circuit breakers, were visually inspected and the following observations were made:

1. All four DB-50 Unit 1 circuit breakers and UV trip attachments were removed from the circuit breaker cabinets. The enclosures were generally clean and free of dust. The ambient temperature was between 85 and 95°F, with warm exhaust air from inverter cabinets being directed at the DB-50 circuit breaker cabinets. The spacing between cabinets is approximately 3 feet.

2. All four DB-50 Unit 2 circuit breakers were also inspected. The UV trip attachments were removed, however. The circuit breaker cabinets contained a layer of loose dust approximately 1/16 inch thick. The ambient temperature was in the 70°F range. UV trip attachments are mounted on the top of the circuit-breaker platform, to the right of the shunt trip attachment, which is several inches from the bottom of the circuit breaker cabinet.

Interviews were conducted with an electrical maintenance supervisor who discussed the circumstances of the removal of the circuit breakers that were involved with the incident on Unit 1, and an electrical supervisor who had also worked on the circuit breakers in question in August 1982. The information received

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was that the circuit breakers and their UV trip attachments had been operated frequently and had operated during surveillance testing within a few days prior to the incident.

A request was made to Salem management to provide one of the UV trip attachments and a shunt trip attachment for testing at Franklin Research Center (FRC). This request was complied with, and an investigation of these devices is now under way at FRC.

Results of Initial Examination

Initial investigations indicated roughness in the operation of the trip latch. There is some dragging of the mechanism, and portions of the latch mechanism have obvious signs of wear. Possible contributing factors to the failure to operate are a lack of lubrication, wear, jarring of the UV attachment as a result of circuit breaker operation and more frequent operation of the UV trip attachment than was intended during design. It is postulated that under most industrial applications, the UV attachment would be used very infrequently and probably would be operated only during test sequences at perhaps yearly or longer intervals. Therefore, in industrial applications, it would operate only a few times, perhaps 20 or 30 cycles during its lifetime, and would not be a normal tripping mechanism for the breaker. However, in its use at Salem and other nuclear power plants, it is the prime tripping device for the circuit breaker, and is therefore called upon to operate on the order of 50 times per year. This would mean that at its current age, in 1983, there would have been possibly 400 to 500 trip operations of this device.

During the initial investigation, it was noted that the shunt trip attachment has been operated once every seven days since August 1982, rather than at longer intervals. This means that the circuit breaker is tripped and closed every seven days. This causes jarring of the entire mechanism of the circuit breaker and its attached relays and coils due to the normal operation of the breaker. This may or may not be significant, but it should be noted that the UV attachment stayed energized during these trips, and its latch mechanism was jarred somewhat by operation of the circuit breaker. This possibly added to the friction built up in the latch mechanism from normal operation by causing the latch mechanism to just slightly nick the surface that it rides on and thereby tend to prevent operation. Further investigation will try to determine whether this is indeed a problem. It appears from initial inspection of the device that wear and roughness of mating surfaces in the trip latch are present. Proper lubrication might have prevented the current situation or could have reduced the roughness to the point where proper operation could occur.

Further investigation will attempt to determine whether the CRC-2-26 lubricating and cleaning spray added to the operating problem by either causing corrosion or removing all residual lubrication from initial construction and possible caking of dust and dirt. It appears that from the time of initial construction of the UV trip attachments up until January of 1983, no lubrication procedures had been performed, and then, in January of 1983, lubrication procedures were undertaken by the maintenance personnel and a Westinghouse technician. At this time, the CRC-2-26 lubricant cleaner was sprayed on all four UV trip attachments associated with the Unit 1 circuit breaker. This lubricant is being procured by FRC for testing purposes.

List of Investigations To Be Performed by NRC Contractor (FRC)

1. The first test will be to perform various deenergizations and energizations of the UV trip attachment and monitor the device under various conditions.

2. The second test will be to disassemble the latch mechanism to observe the surfaces of the various parts of the latch and to photograph these surfaces through a microscope to determine the various levels of wear on these surfaces.

3. The third test is to determine the effects of CRC-2-26 spray on the various types of metals used in this devices. An attempt will be made to use metals other than those in the actual attachment. If possible, the chemical consistency of this spray will be determined from the manufacturer.

To prove that the sample UV trip attachment is identical to all such Salem devices, a visual inspection of all existing Salem Unit 1 and 2 UV trip attachments will be performed. This can take place at Salem, with no disassembly needed. The inspection can be made with the devices mounted on the circuit breakers or loose. These inspections should be done as soon as possible, and Tuesday, March 8, 1983 is recommended.

If further tests are required they will be based on the results of these initial tests. All tests will be nondestructive such that the device can be used for further testing and returned to the utility.

Additional Test To Be Conducted by the Licensee, as Revised by NRC Staff

This test will require the use of a spare circuit breaker. The UV trip and shunt trip attachments will be mounted on the breaker, and the breaker will be operated repeatedly to determine the effect on the shunt and UV trip attachments. It is surmised that while the attachments are energized and the breaker trips and closes a number of times, additional friction of the trip latch may occur from the vibration. This test is described in detail in the following section.

II. REVISED SURVEILLANCE OF REACTOR-TRIP CIRCUIT BREAKER OPERATION AND VERIFICATION TESTING

The licensee proposed the following increased surveillance of reactor-trip circuit breaker operation:

1. Main and bypass breakers will be shunt-tripped weekly.

2. Main breakers will be UV-tripped monthly.

The acceptability of this revised surveillance of reactor-trip circuit breaker operation has been evaluated by NRC staff. Based on an analysis conducted by NRC staff, which considered reactor-trip system unavailability, reactor-trip

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circuit breaker failure rates, and test intervals, the following conclusions were drawn. First, the proposed test of each reactor-trip circuit breaker UV trip attachment once every 30 days is acceptable. Second, the proposed test of the shunt trip attachment once every seven days is considered to be excessive and may impact on the reliability of the reactor trip system by increasing the potential for a single failure. During testing, a single failure in the logic portion of the reactor trip system could prevent an automatic SCRAM. Thus, it is recommended that the shunt trip attachment be tested on the same schedule as the UV trip attachment; that is, once every 30 days. It is also recommended that the UV trip of the bypass breakers be tested prior to restart and every refueling thereafter.

Discussion

The acceptability of the proposed test intervals for the reactor-trip circuit breakers was based on NRC staff review of reactor-trip circuit breaker failure rate data obtained from Licensee Event Reports (LERs). The generic RPS unavailability of 3×10^{-5} (used in both NUREG-0460, "Anticipated Transients Without Scram for Light Water Reactors," and by the ATWS Task Force and Steering Group in the development of the proposed ATWS Rule) was used in evaluating the licensee's proposed test intervals. In addition, the following considerations were incorporated into the NRC staff recommendation:

1. The shunt trip attachment provides a diverse means of tripping the reactor-trip circuit breaker, which is electrically independent of the UV trip attachment. The UV trip attachment is supplied by a 48-V dc source and is deenergized to trip. The shunt trip attachment is supplied by a 125-V dc source and is energized to trip.

2. The shunt trip attachment is an energize-to-actuate device and is not "fail safe" in that a loss of power will not cause a trip. However, the shunt trip is powered from a reliable Class 1E battery-backed source.

3. Since the shunt trip attachment is an energize-to-actuate device, it is not subject to the constant heating effects that the continuously energized UV trip attachment experiences. The heating effects may contribute to the higher failure rate of the UV trip attachment.

4. The mechanical construction of the shunt trip attachment is less complex than that of the UV trip attachment. The shunt trip attachment does not rely on the successful operation of the complex latching mechanism that has been determined to be the source of the majority of the failures of the UV trip attachment.

5. The majority of the electrical circuit breakers used in the high-voltage electrical distribution system have dc-powered energize-to-actuate shunt trip attachments. These circuit breakers are used for manual, as well as automatic, trip functions for load shedding and power switching. Reliability of energize-to-actuate shunt trips in similar applications throughout the nuclear power industry has been shown to be significantly higher than for devices that are constantly energized.

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6. Over 70% of the known reactor-trip circuit breaker failures were caused by UV trip attachment failures.

7. Most of the concerns relating to the events at Salem on February 22 and 25, 1983 are related to the operation of the UV trip attachment. During the events at Salem, the shunt trip attachment functioned properly.

8. The bypass breakers are required to trip in response to a UV trip demand signal should this occur when the main breakers are being tested. Since the test frequency of the main breakers has been increased, the bypass breakers should be tested to verify the capability to perform their backup safety function.

Verification Testing

It is recommended that a bench test be performed on one DB-50 reactor-trip circuit breaker. The purpose of the test will be to cycle the DB-50 with the UV trip and shunt trip attachments in place for a total of 2000 cycles to determine if any adverse effects can be identified and, if there are no adverse effects, show that a properly maintained breaker and its subcomponents can operate for an extended number of cycles. The breaker will be tripped, with each cycle being alternated with the UV and shunt trips. The ambient temperature should be 100°F to simulate the expected service environment, and the circuit breaker should be cycled no more often than once every 30 minutes to allow for return to steady-state conditions. The results of each circuit breaker operation will be documented and a visual check made. Additional details for this type of test will be provided at a later time.

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Appendix B

INITIAL NRC STAFF REVIEW OF LICENSEE'S MAINTENANCE PROCEDURE AND PREOPERATIONAL VERIFICATION PROGRAM

NRC staff reviewed the licensee's maintenance procedure, Salem Generating Station Maintenance Department Manual Maintenance Procedure M3Q-2, Revision 1. This document includes a procedure for verifying proper operation of the UV trip attachment and testing of the UV trip attachment coil following replacement. NRC staff also reviewed the licensee's proposed reactor-trip circuit breaker operational verification program, which references Procedure M3Q-2. The following comments and recommendations were made concerning these documents:

1. The maintenance procedure does not specify whether the maintenance and testing described are applicable to both the main and bypass breakers. It should specify that it does.

2. The maintenance procedure should specify required actions to be taken in the event any acceptable tolerances, as identified in Enclosure 7 of M3Q-2, are not met.

3. The frequency of all maintenance and testing specified in the procedure, with the exception of the verification testing identified following UV trip attachment replacement, should be specified.

4. The procedure should be modified to require cleaning of the entire circuit breaker room, the removal of all four circuit breakers and cleaning of the cabinets by vacuuming, and cleaning of the breakers during every refueling outage.

5. Section 9.7.2.1 of Procedure M3Q-2 specifies that the UV trip attachment is to be cleaned with a standard solvent. The procedure should specify the exact solvent to be used. NRC will request FRC and BNL to determine the adequacy of the proposed solvent and any potential adverse effects from its use. (This evaluation need not be completed prior to plant startup).

6. Section 9.7.2.2 specifies the composition of the lubricant to be applied to specific points of the UV trip attachment. This specification should state whether the mechanism is to be lubricated each time maintenance is performed. NRC will request FRC and BNL to determine the adequacy of the lubricant and the points of application specified, as well as the frequency of lubrication.

7. Any UV trip attachment that does not successfully complete the 25 consecutive cycles of testing to be performed by Westinghouse should not be accepted or installed by the licensee.

8. Section 9.7.4.15 specifies the testing to be performed on the UV trip attachment coil following its replacement. The maintenance procedure

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should be revised to require that all replacement UV trip attachments successfully complete 25 consecutive cycles of testing prior to installation in the plant and start of the ten test cycle specified in the maintenance procedure. The time between each of the ten tests should be specified. NRC recommends 30 minutes for the reasons specified in Appendix A. NRC staff believe the increase in test cycles, and the acceptance criteria specified if any failures occur during this testing, are reasonable and should be incorporated into maintenance procedure M3Q-2.

9. Technical Department Procedures Nos. IIC-18.1.011 and IIC-18.1.010, referenced by the licensee, should be reviewed and their acceptability determined by NRC staff.

Following revision of the maintenance procedure and the associated proposed reactor-trip circuit breaker operational verification program to incorporate the above comments and recommendations. NRC staff will reevaluate the documents and provide another report that will include the results of the NRC contractor's evaluations and will document the final NRC evaluation and conclusions concerning the adequacy of the maintenance procedure and preoperational verification program.