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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
COMPLIANCE WITH ATWS RULE, 10 CFR 50.62
NORTHERN STATES POWER COMPANY
PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS NOS. 1 AND 2
DOCKETS NOS. 50-282 AND 50-306

1.0 INTRODUCTION

On July 26, 1984, the Code of Federal Regulations (CFR) was amended to include Section 10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients Without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants" (known as the ATWS Rule). The requirements of Section 10 CFR 50.62 apply to all commercial light-water-cooled nuclear power plants.

An ATWS is an anticipated operational occurrence (such as loss of feedwater, loss of condenser vacuum, or loss of offsite power) that is accompanied by a failure of the Reactor Trip System (RTS) to shut down the reactor. The ATWS Rule requires specific improvements in the design and operation of commercial nuclear power facilities to reduce the probability of failure to shut down the reactor following anticipated transients and to mitigate the consequences of an ATWS event.

Paragraph (c)(1) of 10 CFR 50.62 specifies the basic ATWS mitigation system requirements for Westinghouse plants. Equipment, diverse from the RTS, is required to initiate the auxiliary feedwater (AFW) system and a turbine trip for ATWS events. In response to paragraph (c)(1), the Westinghouse Owners Group (WOG) developed a set of conceptual ATWS mitigating system actuation circuitry (AMSAC) designs generic to Westinghouse plants. WOG issued Westinghouse Topical Report WCAP-10858, "AMSAC Generic Design Package," which provided information on the various Westinghouse designs.

The staff reviewed WCAP-10858 and issued a safety evaluation of the subject topical report on July 7, 1986 (Ref. 1). In this safety evaluation, the staff concluded that the generic designs presented in WCAP-10858 adequately meet the requirements of 10 CFR 50.62. The approved version of the WCAP is labeled WCAP-10858-P-A.

During the course of the staff's review of the proposed AMSAC design, the WOG issued Addendum 1 to WCAP-10858-P-A by letter dated February 26, 1987 (Ref. 2). This Addendum changed the setpoint of the C-20 AMSAC permissive signal from 70% reactor power to 40% power. On August 3, 1987, the WOG issued Revision 1 to WCAP-10858-P-A (Ref. 3), which incorporated Addendum 1 changes and provided details on changes associated with a new variable timer and the C-20 time delay. For those plants selecting either the feedwater flow or the feedwater pump/valve status logic options, a variable delay timer is to be incorporated into the AMSAC actuation logics. The time delay on the C-20 permissive signal for all logics will be lengthened to incorporate the maximum time that the steam generator takes to boil down to the low-low setpoint upon a loss of MFW with the reactor operating at 40% power. The staff considers the Revision 1 changes to be acceptable.

In accordance with paragraph (c)(6) of the ATWS Rule, Northern States Power Company (NPS) initiated the review of the proposed AMSAC design for the Prairie Island Nuclear Generating Plant by letter dated February 27, 1987 (Ref. 4). During the course of the review, the licensee submitted several documents (Refs.5 through 10) and conducted a presentation at the NRC offices (Ref. 11). The licensee consolidated all of the AMSAC design details from previous submittals in Reference 10, which superseded the earlier submittals. The staff held several conference calls with the licensee. During the final conference call (May 10, 1988), the staff concerns regarding the isolation devices used in the AMSAC design were discussed with the licensee. The licensee responded to these concerns by letter dated May 12, 1988 (Ref. 10).

2.0. REVIEW CRITERIA

The systems and equipment required by 10 CFR 50.62 do not have to meet all of the stringent requirements normally applied to safety-related equipment However, the equipment required by the ATWS Rule should be of sufficient quality and reliability to perform its intended function while minimizing the potential for transients that may challenge the safety systems, e.g., inadvertent scrams.

The following review criteria were used to evaluate the licensee's submittals:

1. The ATWS Rule, 10 CFR 50.62.

2. "Considerations Regarding Systems and Equipment Criteria," published in the Federal Register, Volume 49, No 124, dated June 26, 1984.

3. Generic Letter 85-06, "Quality Assurance Guidance for ATWS Equipment That Is Not Safety Related."

4. Safety Evaluation of WCAP-10858 (Ref. 1).

5. WCAP-10858-P-A, Revision 1 (Ref. 3).

3.0 DISCUSSION AND EVALUATION

To determine that conditions indicative of an ATWS event are present, the licensee has elected to implement the WCAP-10858-P-A AMSAC design associated with monitoring the main feedwater (MFW) flow and activating the AMSAC when the MFW flow is below the low flow setpoint. Also, the licensee will implement the new time delays (described in the introduction section) associated with the C-20 permissive timer and the variable timer as required by Revision 1 to the WCAP.

The Prairie Island ATWS design consists of two AMSAC logic trains. Both logic trains are required to actuate to achieve AMSAC actuation. Thus, if either logic train fails, the AMSAC output signal will be blocked automatically. This design minimizes actuation due to spurious trips. Should such a logic failure occur, an AMSAC trouble alarm will annunciate in the control room to alert the operator.

Many details and interfaces associated with the implementation of the final AMSAC design are of a plant-specific nature. In its safety evaluation of WCAP-10858, the staff identified elements that require resolution for each plant design. The following paragraphs provide a discussion on the licensee's compliance with respect to these plant-specific elements.

1. Diversity

The plant design should include adequate diversity between the AMSAC equipment and the existing Reactor Protection System (RPS) equipment. Reasonable equipment diversity, to the extent practicable, is required to minimize the potential for common-cause failures.

The AMSAC logic will be microprocessor-based and will receive MFW flow input signals from Prairie Island's upgraded main feedwater control system. The licensee has provided information to confirm that the microprocessor-based AMSAC logic circuits will be diverse from the logic circuits of the RPS in the areas of design, equipment, and manufacturing. Where similar types of components are used, such as relays, the AMSAC will utilize a rely of a different make and manufacturer.

2. Logic Power Supplies

Logic power supplies need not be Class 1E, but must be capable of performing the required design functions upon a loss of offsite power. The logic power must come from a power source that is independent from the RPS power supplies.

The licensee has provided information to verify that the logic power supplies used for AMSAC will be independent from the RPS power supplies and will function during the loss of offsite power. The AMSAC power will be from a nonsafety-related power source with battery backup. The subject nonsafety-related bus will have the capability to be powered from a nonsafeguards diesel generator.

3. Safety-Related Interface

The implementation of the ATWS Rule shall be such that the existing Reactor Protection System (RPS) continues to meet all applicable safety criteria.

The licensee has stated that the implementation of the AMSAC/RPS interface will be such that the existing RPS will continue to meet all applicable safety criteria as summarized in the Updated Safety Analysis Report (USAR), Section 8.7. Refer to Item 9 for further discussion on this issue.

4. Quality Assurance

This element requires the licensee to provide information regarding compliance with Generic Letter (GL) 85-06, "Quality Assurance for ATWS Equipment That Is Not Safety Related."

The licensee has confirmed that the QA requirements for installation and operation of the AMSAC equipment will follow the guidelines presented in GL 85-06.

5. Maintenance Bypasses

Information showing how maintenance at power is accomplished should be provided. In addition, maintenance bypass indications should be incorporated into the continuous indication of bypass status in the control room.

The licensee has stated that, during maintenance or surveillance of the AMSAC system or sensor inputs, the AMSAC output signals will be bypassed using a permanently installed bypass switch located at the AMSAC test panel. Continuous indication of the AMSAC bypass will be provided by an AMSAC trouble alarm window that will be located in the main control room. It is the staff's understanding that the licensee will conduct a human-factors review of the subject indication consistent with the plant's control room design process.

6. Operating Bypasses

The operating bypasses should be indicated continuously in the control room. Diversity and independence of the C-20 permissive signal should be provided.

The licensee has provided information stating that the AMSAC will be automatically bypassed below 40% reactor power, as indicated by the turbine first-stage impulse pressure. The bypass condition will be indicated by a control room annunciator. It is the staff's understanding that the licensee will conduct a human-factors review of the bypass annunciators consistent with the plant's detailed control room design process. The C-20 permissive signal will be derived from existing protection system instrumentation and will be processed by the AMSAC logic circuitry which is to be diverse from the reactor protective system. The time delay on de-energization (TDOD) timer associated with the C-20 permissive will be set for a time period that is longer than the actuation variable timer consistent with Revision 1 to WCAP-10858-P-A.

7. Means for Bypasses

The means for bypassing shall be accomplished by the use of a permanently installed, human-factored, bypass switch or similar device. Disallowed methods for bypassing mentioned in the guidance should not be utilized.

The licensee stated that bypassing AMSAC during testing and maintenance will be accomplished with a permanently installed keylock bypass switch. The disallowed methods for bypassing, such as lifting leads, pulling fuses, blocking relays, or tripping breakers, will not be used. It is the staff's understanding that the licensee will conduct a human-factors review of the bypass controls and annunciation consistent with the plant's detailed control room design process.

8. Manual Initiation

Manual initiation capability of the AMSAC mitigation function must be provided.

The licensee discussed how manual turbine trip and auxiliary feedwater actuation are accomplished by the operator. The licensee stated that existing manual controls for turbine trip and AFW actuation are located in the main control room and will be used by the operator to perform the AMSAC function manually, if necessary. Thus, no additional manual initiation capability is required as a result of installing the AMSAC equipment.

9. Electrical Independence From Existing Reactor Protection System

Independence is required from the sensor output to the final actuation device, at which point nonsafety-related circuits must be isolated from safety-related circuits by qualified Class 1E isolators.

The licensee discussed how electrical independence is to be achieved. The proposed design requires isolation between AMSAC and the Class 1E circuits associated with the turbine first stage impulse chamber pressure and the AFW pumps. The licensee has informed the staff that the required isolation will be achieved using electrical isolation devices that have been qualified

and tested to Class 1E electrical equipment requirements. In addition, the isolators will be tested as described in Appendix A to the Safety Evaluation (Ref. 1). The data and information required by Appendix A is to be compiled by the licensee and should be available for review during a subsequent site audit in accordance with Temporary Instruction 2500/20 (Ref. 12).

10. Physical Separation From Existing Reactor Protection System

The implementation of the ATWS mitigating system must be such that the separation criteria applied to the existing RPS are not violated.

The licensee stated that the AMSAC circuitry will be located in separate cabinets and will be physically separated from the RPS. In addition, the AMSAC cable routing will be in accordance with the physical separation criteria originally established for the station at the time of initial plant licensing. Thus, the existing separation criteria for the RPS will not be compromised as a result of installing the AMSAC equipment.

11. Environmental Qualification

The plant-specific submittal should address the environmental qualification of ATWS equipment for anticipated operational occurrences.

The staff was informed that the AMSAC cabinet and equipment will be located in the control room area which is considered a mild environment. The AMSAC equipment will be qualified for environmental conditions associated with anticipated operational occurrences that might occur relative to the respective equipment locations.

12. Testability at Power

Measures to test the ATWS mitigating system before installation, as well as periodically, are to be established. Testing of the system may be performed with the system in the bypass mode. Testing from the input sensor through to the final actuation device should be performed with the plant shut down.

The licensee has stated that the AMSAC equipment will be functionally tested before and after installation. The AMSAC system will be testable at power in the bypass mode in accordance with procedures approved for the Prairie Island plant. Bypassing AMSAC for testing and returning the system to service will be controlled by administrative procedures. The bypassed condition will be continuously indicated in the control room. The periodic at-power testing frequency will be based on manufacturer and engineering recommendations. The end-to-end test (including the AMSAC outputs through to the final actuation devices) will be performed during plant refueling outages.

It is the staff's understanding that the licensee will conduct a human-factors review of the controls and indications used for testing purposes that is consistent with the station's detailed control room design process.

13. Completion of Mitigative Action

The licensee is required to verify that (1) the protective action, once initiated, goes to completion and (2) the subsequent return to operation requires deliberate operator action.

The licensee responded that once the AMSAC is initiated, the circuits for starting the AFW pumps and the turbine trip will go to completion in accordance with existing plant circuit design. Deliberate manual action on the part of the operator, in accordance with plant procedures, will be required to reset the turbine trip circuitry and to restore the AFW pumps to standby status.

4.0 CONCLUSION

Based on the above discussion, the staff concludes that the AMSAC design proposed by Northern States Power Company for the Prairie Island Plant is acceptable and is in compliance with the ATWS Rule, 10 CFR 50.62, paragraph (c)(1). The staff's conclusion is further subject to the successful completion of certain noted human-factors engineering reviews and to the satisfactory completion of isolation devices qualification to which the licensee has committed. It is the staff's position that the AMSAC should not be declared operational prior to successful qualification of the electrical isolation devices in accordance with Appendix A to the staff's SER (Ref. 1)

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5.0 REFERENCES

1. Letter, C. E. Rossi (NRC) to L. D. Butterfield (WOG), "Acceptance for Referencing of Licensing Topical Report," July 7, 1986.

2. Letter, R. A. Newton (WOG) to J. Lyons (NRC), "Westinghouse Owners' Group Addendum 1 to WCAP-10858-P-A and WCAP-11233-A: AMSAC Generic Design Package," February 26, 1987.

3. Letter, R. A. Newton (WOG) to J. Lyons (NRC), "Westinghouse Owners' Group Transmittal of Topical Report, WCAP-10858-P-A, Revision 1, AMSAC Generic Design Package," August 3, 1987.

4. Letter, D. Musolf, (NSP) to U.S. NRC, "Plant Specific AMSAC Design," February 27, 1987.

5. Letter, D. Musolf (NSP) to U.S. NRC, "Response to NRC Request for Further Information on Prairie Island Plant Specific AMSAC Design," April 3, 1987.

6. Letter, D. Musolf (NSP) to U.S. NRC, "Revisions to Schedule for Implementation of AMSAC and to the Plant Specific AMSAC Design," August 28, 1987.

7. Letter, D. Musolf (NSP) to Director, NRR, "Revision to Plant Specific AMSAC Design," December 1, 1987.

8. Letter, D. Musolf (NSP) to Director, NRR, "Additional Information Related to AMSAC Design," March 15, 1988.

9. Letter, D. Musolf (NSP) to Director, NRR, "Description of Final AMSAC Design," April 22, 1988.

10. Letter, D. Musolf (NSP) to Director, NRR, "Supplemental Information - Final AMSAC Design," May 12, 1988.

11. Meeting with the NRC staff, "Implementation of the Median Signal Selector in the Advanced Digital Feedwater Control System," Bethesda, Maryland, September 15, 1987.

12. Temporary Instruction 2500/20, "Inspection to Determine Compliance with ATWS Rule, 10 CFR 50.62," February 9, 1987.