UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ARKANSAS NUCLEAR ONE, UNIT 2

EVALUATION OF COMPLIANCE WITH THE ATWS RULE: 10 CFR 50.62

REQUIREMENTS FOR REDUCTION OF RISK

FROM ANTICIPATED TRANSIENTS WITHOUT SCRAM (ATWS) EVENTS

FOR LIGHT-WATER-COOLED NUCLEAR POWER PLANTS

1.0 INTRODUCTION

On July 26, 1984, the Code of Federal Regulations (CFR) was amended to include the "ATWS Rule" (Section 10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients Without Scram [ATWS] Events for Light-Water-Cooled Nuclear Power Plants"). An ATWS is an expected operational transient (such as loss of feedwater, loss of condenser vacuum, or loss of offsite power), which 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 likelihood of failure to shut down the reactor following anticipated transients and to mitigate the consequences of an ATWS event.

The 10 CFR 50.62 requirements applicable to pressurized water reactors manufactured by Combustion Engineering, such as Arkansas Nuclear One, Unit 2 (ANO-2), are:

(1) Each pressurized water reactor must have equipment from sensor output to final actuation device that is diverse from the reactor trip system, which will automatically initiate the auxiliary (or emergency) feedwater system and initiate a turbine trip under conditions indicative of an ATWS. This equipment must be designed to perform its function in a reliable manner and be independent (from sensor output to the final actuation device) from the existing reactor trip system.

(2) Each pressurized water reactor must have a diverse scram system from the sensor output to interruption of power to the control rods. This scram system must be designed to perform its function in a reliable manner and be independent from the existing reactor trip system (from sensor output to interruption of power to the control rods).

In summary, the ATWS Rule requirements for ANO-2 are to install a diverse scram system (DSS), diverse circuitry to initiate a turbine trip (DTT) and diverse circuitry for initiation of auxiliary feedwater (DAFW).

2.0 BACKGROUND

Paragraph (c)(6) of the ATWS Rule requires that detailed information to demonstrate compliance with the requirements of the Rule be submitted to the Director, Office of Nuclear Reactor Regulation (NRR). In accordance with Paragraph (c)(6) of the ATWS Rule, Combustion Engineering Owners Group (CEOG) provided information to the staff by letter dated September 18, 1985 (Ref. 1). The letter forwarded CEN-315, "Summary of the Diversity Between the Reactor Trip System and the Auxiliary Feedwater Actuation System for CE Plants," for staff review.

The staff reviewed CEN-315 and, by letter dated August 4, 1986 (Ref. 2), forwarded its conclusion to the CEOG. The staff concluded that sufficient diversity did not exist between the reactor trip system (RTS) and the auxiliary feedwater actuation system (AFAS) to achieve the degree of reduction in potential common mode failure (CMF) mechanisms by providing hardware diversity as required by the ATWS Rule. This decision affected San Onofre Nuclear Generating Station, Units 2 and 3 (SONGS-2, -3), Arkansas Nuclear One, Unit 2 (ANO-2), and Waterford Steam Electric Station, Unit 3 (WSEC-3).

In response to the staff's evaluation of CEN-315, Southern California Edison (SCE), the licensee for SONGS-2, -3, submitted CEN-349 to the staff by letter dated December 30, 1986 (Ref. 3). CEN-349 provided additional

information to support the CEOG position stated in CEN-315. The staff reviewed CEN-349 and, by letter dated January 11, 1988 (Ref. 4), again rejected the CEOG position that the existing diversity between the RTS and the AFAS meets the requirements of the ATWS Rule.

In a further attempt to gain a favorable staff position, Arkansas Power & Light Company (AP&L), licensee for ANO-2, by letter dated November 3, 1988 (Ref. 5), submitted a plant-specific request for an exemption from the portion of the ATWS Rule that requires equipment diverse from the RTS to initiate the AFAS under conditions indicative of an ATWS. The submittal also provided detailed design information on the DSS and DTT. The staff reviewed the submittal and, by letter dated December 28, 1988 (Ref. 6), forwarded a Request for Additional Information (RAI) on the licensee's proposed DSS/DTT design. In addition, the staff denied the licensee's request for an exemption by letter dated February 16, 1989 (Ref. 7).

The licensee responded to the RAI by letter dated February 2, 1989 (Ref. 8). A conference call was held with the licensee on February 10, 1989, to discuss the information contained in the response to the RAI. The licensee responded to the conference call by letter dated February 21, 1989 (Ref. 9).

This safety evaluation addresses the licensee's conformance to the ATWS Rule at ANO-2, as detailed in References 5, 8, and 9.

3.0 CRITERIA

The purpose of the ATWS Rule, as documented in SECY-83-293, "Amendments to 10 CFR 50 Related to Anticipated Transients Without Scram (ATWS) Events," is to require equipment/systems that are diverse from the existing reactor trip system (RTS) and capable of preventing or mitigating the consequences of an ATWS event. The failure mechanism of concern is a common mode failure (CMF) of identical components within the RTS (e.g., logic circuits; actuation devices; and instrument channel components, excluding sensors).

The hardware/component diversity required by the ATWS Rule is intended to ensure that CMFs that could disable the electrical portion of the existing reactor trip system will not affect the capability of ATWS prevention/mitigation system(s) equipment to perform its design functions. Therefore, the similarities and differences in the physical and operational characteristics of these components must be analyzed to determine the potential for CMF mechanisms that could disable both the RTS and ATWS prevention/mitigation functions.

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, this equipment is part of the broader class of structures, systems, and components important to safety defined in the introduction to 10 CFR 50, Appendix A (General Design Criteria [GDC]). GDC-1 requires that "structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed." The criteria used in evaluating the licensee's submittal include 10 CFR 50.62, "Rule Considerations Regarding Systems and Equipment Criteria," published in the Federal Register, Volume 49, No. 124, dated June 26, 1984. Generic Letter No. 85-06, dated April 16, 1985, "Quality Assurance Guidance for ATWS Equipment That is Not Safety Related," details the quality assurance requirements applicable to the equipment installed per ATWS Rule requirements.

To minimize the potential for common mode failures, diversity is required for diverse scram system (DSS) equipment from sensor output to, and including, the components used to interrupt control rod power. The use of circuit breakers from different manufacturers is not, by itself, sufficient to provide the required diversity for interruption of control rod power. For mitigating systems (i.e., diverse turbine trip and diverse auxiliary feedwater actuation system), diversity is required from sensor output to, but not including, the final actuation device.

Electrical independence between ATWS circuits (i.e., DSS, DTT, and DAFW) and the existing RTS circuits is considered desirable to prevent interconnections between systems that could provide a means for CMFs to potentially affect both systems. Where electrical independence is not provided between RTS circuits and circuits installed to prevent/mitigate ATWS events, it must be demonstrated that faults within the DSS, DTT, or DAFW actuation circuits cannot degrade the reliability/integrity of the existing RTS below an acceptable level. It must also be demonstrated that a CMF affecting the RTS power distribution system, including degraded voltage and frequency conditions (the effects of degraded voltage conditions over time must be considered if such conditions can go undetected), cannot compromise both the RTS and ATWS prevention/mitigation functions.

Electrical independence of nonsafety-related ATWS circuits from safety-related circuits is required in accordance with the guidance provided in IEEE Standard 384, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," as supplemented by Regulatory Guide (RG) 1.75, Revision 2, "Physical Independence of Electric Systems."

The equipment required by 10 CFR 50.62 to reduce the risk associated with an ATWS event must be designed to perform its functions in a reliable manner. The DSS, DTT, and DAFW circuits must be designed to allow periodic testing to verify operability while at power. Compliance with the reliability and testability requirements of the ATWS Rule must be ensured by technical specification operability and surveillance requirements or equivalent means that govern the availability and operation of ATWS equipment; thereby ensuring that the necessary reliability of the equipment is maintained.

The ATWS prevention and mitigation systems should be designed to provide the operator with accurate, complete, and timely information that is pertinent to system status. Displays and controls should be properly integrated into the main control room and should conform to good human-engineering practices in design and layout.

4.0 DISCUSSION AND EVALUATION

The following is a discussion on the licensee's compliance to the guidance contained in the Federal Register, "Statement of Considerations" (Ref. 10) and to the requirements of the ATWS Rule as discussed in Section 3 of this report.

4.1 DIVERSE SCRAM SYSTEM

A. GENERAL

AP&L intends to implement the ANO-2 DSS design as a control-grade system by using new pressurizer pressure transmitters on existing taps to provide signals to the DSS in a two-out-of-four trip logic. High pressurizer pressure will be used as the parameter indicative of an ATWS. The DSS will consist of four measurement channels, four two-out-of-four logics, and two trip paths. Each measurement channel consists of a pressure transmitter sensor; a signal conditioner; and an alarm block and timer block, which are part of the configured function block of a Foxboro Spec. 200 Micro Control Module.

The DSS trip setpoint will be set greater than the RPS high pressurizer pressure trip setpoint and less than the primary safety valve relief pressure setpoint. Each of the four, two-out-of-four logics activates one of the two trip paths to open a motor-generator (MG) set output contactor. This occurs when any two of the four inputs from the four measurement channels reach the high-high pressurizer pressure setpoint simultaneously.

Activation of channel 1 and/or 3 of the two-out-of-four logic energizes the Trip Path #1 relay, which opens the MG Set #1 output contactor. Activation of channel 2 and/or 4 of the two-out-of-four logic energizes the Trip Path #2 relay, which opens the MG Set #2 output contactor.

Activation of both trip paths is require to initiate a reactor trip. Once the trip is actuated, it is sealed until manually reset at the DSS panel.

B. DIVERSITY

Hardware/component diversity is required for all diverse scram system (DSS) equipment from sensor outputs to, and including, the components used to interrupt control rod power. The use of circuit breakers from different manufacturers is not, by itself, sufficient to provide the required diversity for interruption of control rod power. The DSS sensors are not required to be diverse from the RTS sensors. However, separate sensors are preferred to prevent interconnections between the DSS and the existing reactor protection system (RPS or RTS).

The ANO-2 DSS design consists of four safety-relate instrument channels, each of which provides an input to two, separate, two-out-of-four, energize-to-actuate logic matrices. The output of each logic is used to open one of the two RPS motor-generator (MG) set output contactors. Both contactors must open to remove power from the control element assemblies (CEA), causing a reactor scram. The instrument channels consist of sensors, bistables, bistable relays, and actuation relays.

The sensors used in the DSS are separate from the existing RPS pressure transmitters. They do, however, share existing pressure sensing lines through instrument valves. The DSS transmitter circuits are completely independent from the existing RPS instrument loops. Additionally, the DSS transmitters are qualified for Class 1E application and are Seismic Category I in design. This sensor design exceeds the requirements of the ATWS Rule.

The ANO-2 DSS design does not specifically use bistables or bistable relays in its design. The functions are performed by the Foxboro Spec. 200 Micro Control Module. For this function, the RPS uses

bistables manufactured by Gould and Electro-Mechanics and bistable relays manufactured by Electro-Mechanics. The DSS actuation devices are Foxboro output relay modules and MG set trip relays, which open the M-G set output load contactors. The actuation devices are powered from a non-Class 1E instrument AC-power panel. The parallel device in the RPS is a mechanical circuit breaker powered by a Class 1E vital bus.

Based on the above, the staff concludes that the level of hardware/component diversity provided between the DSS circuits and the existing RPS circuits at ANO-2 is sufficient to comply with the requirements of 10 CFR 50.62 (the ATWS Rule) and is, therefore, acceptable.

C. DSS ELECTRICAL INDEPENDENCE/POWER SUPPLIES

The purpose of the electrical independence requirements of the ATWS Rule is to prevent interconnections between the DSS and RPS (thereby reducing the potential for CMFs that could affect both systems) and to ensure that faults within DSS circuits cannot degrade the RPS. Electrical independence of DSS circuits from RPS circuits should be maintained from sensor outputs up to the final actuation devices. The use of a common power source for the DSS and RPS sensors is acceptable because, in accordance with the ATWS Rule, the sensors can be shared between these two systems.

The DSS at ANO-2 receives power from two, separate, non-Class 1E instrument AC power sources. The logic power is supplied by four Foxboro power supplies. The power supplies for logic channels 1 and 2 operate in parallel, and the power supplies for logic channels 3 and 4 operate in parallel. Dual power supplies, manufactured by Computer Products, Inc. (CPI), supply power to the multiplexer. The RPS power source is a Power Mate 12 VDC power supply that takes its power from the Class 1E AC vital bus. In addition to power

supply diversity and independence, electrical separation is also maintained; therefore, the proposed design does not need or use electrical isolation devices.

The two, separate, non-Class 1E instrument AC power sources are both diesel backed. They supply power to two small battery chargers that maintain two, 24 VDC batteries. Upon the loss of offsite power, these two batteries will meet the DSS electrical load requirements for more than 15 minutes.

Based on the above, the staff concludes that the DSS power supply configuration is acceptable, as it minimizes the potential for CMFs and other faults to degrade both the DSS and RPS. The power supply configuration is operable upon the loss of offsite power.

D. DSS RELIABILITY/TESTABILITY/MAINTENANCE

To ensure that the DSS circuits perform their safety functions when called on, the Commission issued Generic Letter (GL) 85-06 (Ref. 9), "Quality Assurance Guidance for ATWS Equipment that is not Safety Related," which details the quality assurance requires for equipment installed per ATWS Rule requirements. In addition, the staff requires that circuits be maintained and periodically tested at power in accordance with technical specifications operability and surveillance requirements or equivalent means.

The licensee has stated that the ANO-2 DSS circuits will be installed, maintained, tested, and modified in accordance with the plant's Quality Assurance Manual-Operations. This manual has been compared with GL 85-06, and its requirements meet or exceed those of GL 85-06. The operability and reliability of the DSS will be demonstrated and

maintained by maintenance and surveillance programs that are designed for the DSS and incorporated into the plant's Reliability Assurance Program. Testing of the DSS will be performed prior to installation. The following test schedule will be established:

1. At-Power Testing - Monthly and prior to each return to criticality after a forced or scheduled outage greater than 7 days in length.

2. End-to-End Testing - Refueling outage basis.

The licensee confirmed that maintenance and test bypasses will be built in and will be part of the circuits. Temporary modifications of the circuits for testing and maintenance will not be required. When a protection action is activated, or when any part of the DSS is placed in a bypass condition, an alarm annunciator is actuated in the main control room.

Based on the above, the staff concludes that the DSS surveillance testing proposed by the licensee, the means used to bypass the DSS for test and maintenance purposes, and the indication of the bypass condition are in accordance with good design practices and the requirements of 10 CFR 50.62 (the ATWS Rule) and are, therefore, acceptable.

E. OTHER DSS CONSIDERATIONS

Other system design considerations that enhance the DSS at ANO-2 include:

1. The energize-to-trip circuits will be used to exclude the activation of a trip by component failure.

2. The DSS equipment will be qualified for the environment in which it will be installed.

3. The DSS will have provisions for manual initiation of the system.

4. Once initiated, the DSS will seal-in and require deliberate manual operator action to reset the system.

5. The DSS alarms will be consistent with the plant's Control Room Design Review and good human-engineering practices. As a minimum the following will be annunciated:

   - o DSS Reactor Trip Confirmed
   - o DSS Reactor Trip Demand
   - o DSS Channel Trip
   - o DSS Channel in Test/Bypass
   - o DSS System Trouble

F. CONCLUSION

Based on the above evaluation, the staff concludes that the proposed design of the Diverse Scram System for Arkansas Nuclear One, Unit 2, conforms to the requirements of 10 CFR 50.62 (the ATWS Rule) and is, therefore acceptable.

4.2 DIVERSE TURBINE TRIP

A. GENERAL

The DTT design for ANO-2 consists of four, control-grade instrument channels that sense control element drive mechanism (CEDM) power bus undervoltage in a selective two-out-of-four logic. When the DSS causes a reactor scram, power is interrupted to the CEDM coils upstream of the rod power bus undervoltage relays. The de-energizing of these undervoltage relays actuates the turbine trip circuitry.

The DTT design shares all circuit components with the DSS up to, but not including, the final turbine trip device. Those components that are unique to the DTT (i.e., undervoltage relays, trip relays, master trip relays, and the master solenoid) do not appear in any of the RTS trip paths. All of the information that is applicable to the DSS components and system, as discussed in Section 4.1 of this report, is also applicable to DTT components up to, but not including, the final trip device.

B. CONCLUSION

Based on the above evaluation, the staff concludes that the proposed design for the Diverse Turbine Trip for ANO-2 conforms to the requirements of 10 CFR 50.62 (the ATWS Rule) and is, therefore, acceptable.

4.3 DIVERSE AUXILIARY FEEDWATER ACTUATION

A. GENERAL

As discussed in Section 2.0 of this report, the Auxiliary Feedwater Actuation System (AFAS) at ANO-2 was the subject of a Request for Exemption (RFE) from the ATWS Rule. By letter dated February 16, 1989 (Ref. 7), the staff informed the licensee that the RFE to the ATWS Rule had been denied. The bases for this rejection were that (1) the licensee had presented no new information in the RFE and (2) the cost-benefit and value/impact ratios had been considered during the preparation of, and prior to issuance of, the ATWS Rule. Therefore, the AFAS design will not be evaluated at this time, and the diversity of the AFAS with respect to the RPS is an open item for the purpose of this report. The staff has informed the licensee (Ref. 7) that implementation of the ATWS Rule should be independent of the staff's review of the proposed equipment design.

B. CONCLUSIONS

The licensee should begin or continue the schedule for implementing the diverse AFAS as agreed upon by CEOG with the staff and which is to be documented on April 17, 1989. The staff recommends that the design documentation associated with the diverse AFAS design be provided to the staff for our review as soon as it is available. However, the final compliance of the AFAS with the ATWS Rule will be determined by a post-implementation inspection at ANO-2.

5.0 TECHNICAL SPECIFICATION REQUIREMENTS

The staff is presently evaluating the need for technical specification operability and surveillance requirements, including actions considered appropriate when operability requirements cannot be met (i.e., limiting conditions for operation) to ensure that equipment installed per the ATWS Rule will be maintained in a operable condition. In its Interim Commission Policy Statement on Technical Specification Improvements for Nuclear Power Plants [52 Federal Register 3778, February 6, 1987], the Commission established a specific set of objective criteria for determining which regulatory requirements and operating restrictions should be included in Technical Specifications.

This aspect of the staff's review of ANO-2's design compliance with the ATWS Rule remains open pending completion of the staff's review to determine whether and to what extent Technical Specifications are appropriate. The staff will provide guidance regarding the Technical Specification requirements for DSS, DTT, and DAFW at a later date. Installation of ATWS prevention/mitigation system equipment should not be delayed pending the development or staff approval of operability and surveillance requirements for ATWS equipment.

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6.0 REFERENCES

1. Letter, R. G. Wells (CEOG) to F. Rosa (NRC), "CEN-315 Summary of the Diversity Between the Emergency Feedwater Actuation System for C-E Plants," September 18, 1985.

2. Letter, D. M. Crutchfield (NRC) to R. W. Wells (CEOG), "Staff Evaluation of CEN-315," August 4, 1986.

3. Letter, M. O. Medford (SCE) to G. W. Knighton (NRC), "San Onofre Nuclear Generating Station, Units 2 and 3 (Submittal of CEN-349)," December 30, 1986.

4. Letter, G. W. Knighton (NRC) to K. P. Baskin (SCE) and J. C. Holcombe (SDG&E), "NRC Evaluation of CEN-315 and CEN-349," January 11, 1988.

5. Letter, D. R. Howard (AP&L) to J. A. Calvo (NRC), "Request for Partial Exemption for ANO-2 From the Requirements of 10 CFR 50.62," November 3, 1988.

6. Letter, C. Poslusny, Jr. (NRC) to T. G. Campbell (P&L), "Request for Additional Information," December 28, 1988.

7. Letter, G. M. Holahan (NRC) to T. G. Campbell (AP&L), "Nuclear Reactor Regulation Response to the Arkansas Power and Light Request for Partial Exemption from the Requirements of 10 CFR 50.62 for Arkansas Nuclear One, Unit 2 (TAC No. 59069)," February 16, 1989.

8. Letter, D. R. Howard (AP&L) to J. A. Calvo (NRC), "Response to NRC Request for Additional Information - Diverse Scram System, " February 2, 1989.

9. Letter, D. R. Howard (AP&L) to J. A. Calvo (NRC), "ANO-2 ATWS Request for Additional Information, Supplemental Response," February 21, 1989.

10. Statement of Considerations, Federal Register, Vol 49, No. 124, June 26, 1984.