



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

COMPLIANCE WITH ATWS RULE 10CFR50.62

RELATING TO ALTERNATE ROD INJECTION (ARI),

STANDBY LIQUID CONTROL SYSTEM (SLCS), AND

RECIRCULATING PUMPS TRIP (RPT) SYSTEM

DOCKET NOS. 50-387 AND 50-388

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"). 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 shutdown 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 shutdown the reactor following anticipated transients, and to mitigate the consequences of an ATWS event.

For each boiling water reactor, three systems are required to mitigate the consequences of an ATWS event.

1. It must have an alternate rod injection (ARI) system that is diverse (from the reactor trip system) from sensor output to the final actuation device. The ARI system must have redundant scram air header exhaust valves. The ARI 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 the final actuation device.
2. It must have a standby liquid control system (SLCS) with a minimum flow capacity and boron content equivalent in control capacity to 86 gallons per minute of 13 percent by weight of sodium pentaborate solution. The SLCS and its injection location must be designed to perform its function in a reliable manner.
3. It must have equipment to trip the reactor coolant recirculating pumps automatically under conditions indicative of an ATWS. This equipment must be designed to perform its function in a reliable manner.

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.

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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." Generic Letter 85-06 "Quality Assurance Guidance for ATWS Equipment that is not Safety Related" details the quality assurance that must be applied to this equipment.

In general, the equipment to be installed in accordance with the ATWS rule is required to be diverse from the existing RTS, and must be testable at power. This equipment is intended to provide needed diversity (where only minimal diversity currently exists in the RTS) to reduce the potential for common mode failures that could result in an ATWS leading to unacceptable plant conditions. The criteria used in evaluating the licensee's submittal include 10 CFR 50.62 "Rule Considerations Regarding Systems and Equipment Criteria" published in Federal Register Volume 49, No. 124 dated June 26, 1984 and Generic Letter 85-06 "Quality Assurance Guidance for ATWS Equipment that is not Safety Related."

3.0 SYSTEMS DESCRIPTION

Both Susquehanna Units 1 & 2 have installed the Alternate Rod Injection (ARI) System and the ATWS Recirculation Pump Trip System (RPT) to mitigate the potential consequences of an anticipated transient without scram event. The systems consist of reactor pressure and reactor water level sensors, logic, power supplies, and instrumentation to initiate the protective actions. Except for common instrument sensing lines, the systems are independent from the reactor trip system. The systems initiate the protective actions when both input channels indicating low water level or high pressure are tripped. The systems output will energize the devices to start the protective actions. The systems can be manually initiated by operator action in the control room. The Standby Liquid Control Systems incorporate two pump operation in accordance with the requirements of 10 CFR 50.62 paragraph (C) (4), and will achieve the shutdown timing requirements of Ref. 4. The ARI logic will cause the immediate energization of the Alternate Rod Insertion valves when the reactor vessel high pressure trip setpoint or the low water level trip setpoint is reached. The ARI valves and bleed paths are sized to allow insertion of all control rods to begin within 15 seconds. Positive position (open or closed) is indicated for all ARI valves. The ARI and RPT trip systems share input channels up to the first trip channel relay.

The function of the RPT is to reduce the severity of thermal transients on fuel elements by tripping the recirculation pumps early in the transient events (such as turbine trip, or load rejections). The rapid core flow reduction increases void content and thereby introduces negative reactivity in the reactor systems to trip the recirculation pumps. The design has breakers with two separate trip coils, one receives a trip signal from the end of cycle recirculation pump trip (EOC-RPT) and the other receives a trip signal from the end of cycle recirculation pump trip (EOC-RPT) and the other receives a trip signal from the ATWS-RPT system. The trip coils are separate but not isolated.

The ARI & RPT systems can be tested while the plant is operating. The tests check system operation from the sensor outputs thru the logic to the actuation devices. The ARI/RPT sensors, logic, actuation devices and the circuits are separate from the RTS, and are environmentally qualified to anticipated operational occurrence conditions.

The ARI function can be reset by the ARI reset switches after 25 seconds time delay to ensure that the ARI scram goes to completion. The RPT functions can be reset by manipulation of the RPT reset switches, provided the permissive signal is present.

4.0 EVALUATION OF ARI SYSTEM

4.1 ARI SYSTEM FUNCTION TIME

The licensee stated that the ARI system has been designed to meet the scram time such that rod injection motion will begin within 15 seconds and be completed within 25 seconds from ARI initiation. The scram time performance will be confirmed by testing the complete system. The licensee is required to document these test results. The staff verification of these test results will be part of the implementation inspection to be performed by NRC. (Temporary Instruction 2500/20)

4.2 SAFETY RELATED REQUIREMENTS (IEEE STANDARD-279)

The ATWS rule does not require the ARI system to be safety grade, but the implementation must be such that the existing protection system continues to meet all applicable safety related criteria.

The licensee stated that the ARI system is designed as a safety-related Class 1E system with Class 1E power sources in accordance with existing electrical separation criteria. Any single electrical failure in the ARI system will not prevent the safety related systems from performing their protective functions. This is in conformance with the ATWS rule guidance, and therefore is acceptable.

4.3 REDUNDANCY

The ATWS rule requires that the ARI system must have redundant scram air header exhaust valves, but the ARI system itself does not need to be redundant.

The Susquehanna ARI system has redundant scram air header vent and block valves. The initiation and control circuits are redundant. The ARI system performs a function redundant to the backup scram system. This is in conformance with the ATWS rule guidance, and therefore is acceptable.

4.4 DIVERSITY FROM EXISTING RTS

The ATWS rule requires that the ARI system should be diverse from the existing reactor trip system. The ARI system uses energize-to-function valves instead

of de-energize-to-function valves. It has dc powered valve actuators and logic instead of ac powered valve actuators and logic. The licensee stated that all trip system components, except for Reactor Steam Dome pressure sensors, are diverse from components used for the RPS actuation. The licensee installed the Barksdale pressure switches for the Reactor Steam Dome pressure which initiates the ARI actuation, similar type of pressure switches are used for the RPS actuation. The pressure switches are fed to the diverse actuation logics, respectively. In accordance with the ATWS rule guidance, the sensors need not be of a diverse design or manufacturer. The staff finds this feature of the Susquehanna design acceptable.

4.5 ELECTRICAL INDEPENDENCE FROM THE EXISTING RTS

The ARI actuation is independent from the RPT logic. The ARI circuits and power sources are totally independent from the RTS circuits and power sources. The staff finds this acceptable.

4.6 PHYSICAL SEPARATION FROM EXISTING RTS

The ATWS rule guidance states that the implementation of the ARI system must be such that separation criteria applied to the existing protection system are not violated.

Except for the use of common instrument sensing lines, the ARI system is separate and independent from the Reactor Trip System. It has redundant circuits located in divisionally separated control panels. Either circuit train can perform the protective action. The separation between the RTS and the ARI system satisfies the guidance provided in the ATWS rule, and therefore is acceptable.

4.7 ENVIRONMENTAL QUALIFICATION

The ATWS rule guidance states that the qualification of the ARI system is for anticipated operational occurrences only, not for accidents.

The ARI system is qualified to the anticipated operational occurrence condition. The staff finds this acceptable.

4.8 QUALITY ASSURANCE

The ARI system is designed as a Class 1E system which complies with the quality assurance requirements of 10 CFR 50 Appendix B. This is in conformance to the ATWS rule guidance on QA requirements.

4.9 SAFETY RELATED (IE) POWER SUPPLY

The ATWS rule guidance states that the ARI system must be capable of performing its safety function with loss of offsite power, and that the power source should be independent from the existing reactor trip system.

The ARI systems are powered from the Class 1E 125 Vdc station batteries. The ARI system is capable of performing its safety functions with loss of offsite power and the ARI power sources are independent from the existing RPS system logic and scram pilot solenoid valve actuation power source. The staff finds this acceptable.

4.10 TESTABILITY AT POWER

The ATWS rule guidance states that the ARI system should be testable at power.

The ARI system is fully testable from sensors to the final actuation device while the plant is at power operation. The ARI system uses a redundant 2-out-of-2 coincident logic arrangement. Each individual level and pressure instrument can be tested during plant operation without initiating the ARI system since two level or two pressure signals must be present in the same division to initiate the action. Actuation of the ARI valves can be bypassed during surveillance testing to prevent spurious ARI actuation. These bypasses are through key lock controlled switches and are continuously alarmed in the main control room. The staff finds this acceptable.

4.11 INADVERTENT ACTUATION

The ATWS rule guidance states that inadvertent ARI actuation which challenges other safety systems should be minimized.

The ARI system has coincident logic circuits and, as a result, two sensor channels must be tripped in order to initiate the protective actions. The manual initiation also requires the activation of two switches to initiate the action. As a result, inadvertent actuation is minimized. This is in conformance with the ATWS rule guidance, and therefore is acceptable.

4.12 MANUAL INITIATION

The ARI system has armed manual initiation switches located adjacent to the Standby Liquid Control System in the control room. The staff finds this acceptable.

4.13 INFORMATION READOUT

The ARI system provides status indications (ARI valve position) and alarms in the control room for ARI system trip and ARI trip system bypass activation. The plant computer system and transient monitoring system record ARI trip sequence of events. The staff finds this acceptable.

4.14 COMPLETION OF PROTECTIVE ACTION ONCE IT IS INITIATED

The ARI system has a seal-in feature (inhibited reset for 25 seconds after the last initiation signal) to ensure the completion of protective action once it is initiated. After initial conditions return to normal, deliberate operator action is required to reset the system logic to normal. The staff finds this acceptable.

4.15 CONCLUSION ON ARI SYSTEM

Based on this review, the ARI design basis requirements identified above are in compliance with ATWS rule 10 CFR 50.62 paragraph (C)(3) and the guidance published in Federal Register Volume 49 No. 124 dated June 26, 1984, and therefore is acceptable.

5.0 EVALUATION OF STANDBY LIQUID CONTROL SYSTEM

By letters dated April 6, 1987, and July 20, 1987, the licensee proposed to use two pump operation of SLCS to meet the requirements of 10 CFR 50.62 paragraph (C)(4).

The ATWS rule requires that the SLCS be equivalent in control capacity to a system with an 86 gpm injection rate, using 13 weight percent natural, unenriched sodium pentaborate solution, in a system with a 251 inch diameter reactor vessel. Of the several proposed approaches presented in the General Electric report (Ref. 3) and approved in the NRC evaluation (Ref. 4), the licensee has chosen to use two pump operation with an injection rate of 82.4 gpm and a minimum concentration of 13.6 weight percent sodium pentaborate solution. The licensee also states that each SLC pump has been provided with its own separate suction line to assure that adequate net positive suction head will be available. During Unit 1 3rd refueling outage, a dual pump operation test was successfully performed by the licensee to verify a flow of at least 82.4 gpm at a discharge pressure greater than or equal to 1190 psig. Periodic single pump tests will continue to be performed in accordance with existing specifications.

The Susquehanna Steam Electric Station's SLCS design is, therefore, consistent with the ATWS requirements of 10 CFR 50.62 Paragraph (C)(4). However the plant technical specifications should be modified to reflect a minimum poison solution concentration of 13.6 weight percent sodium pentaborate.

6.0 EVALUATION OF ATWS/RPT SYSTEM

By letter dated April 6, 1987, the licensee stated that the present ATWS/RPT system at Susquehanna station conforms to the standard Monticello design. The ATWS/RPT design is a divisionally separate and redundant class 1E trip system with two-out-of-two trip channels for actuation. Either high reactor pressure or low-low reactor water level from two separate channels will energize a trip coil in each recirculating pump motor-generator set drive motor breaker. It uses two independent coils in each breaker.

As stated in Reference 4, the Monticello design is an acceptable reference for the ATWS/RPT design. The staff concludes that the Susquehanna ATWS/RPT design is in compliance with the ATWS rule, 10CFR50.62 paragraph (c)(5); and therefore is acceptable.



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7.0 TECHNICAL SPECIFICATIONS

The equipment required by the ATWS rule to reduce the risk associated with an ATWS event must be designed to perform its function in a reliable manner. A method acceptable to the staff for demonstrating that the equipment satisfies the reliability requirements of the ATWS rule is to provide equipment technical specifications including operability and surveillance requirements. The licensee has implemented the ATWS/RPT system instrumentation in the Susquehanna Units 1 and 2 plant technical specifications. The staff will provide guidance on technical specification requirements for the ARI system in a separate document.

In the case of SLCS, the staff has accepted the licensee's proposal of operation with a minimum required sodium pentaborate concentration of 13.6 weight percent. The staff has taken the position that the plant Technical Specifications should be modified to require a minimum sodium pentaborate concentration of 13.6 weight percent.

8.0 CONCLUSIONS

Based on the above evaluation, the staff concludes that the SSES Units 1 and 2 comply with the requirements of 10 CFR 50.62.

9.0 REFERENCES

1. Pennsylvania Power and Light Company letter from H.W. Keiser to NRC dated April 6, 1987.
2. Susquehanna FSAR revision 39 dated July 1988.
3. BWROG Topical Report NEDE-31096-P "Anticipated Transients Without Scram; Response to NRC ATWS Rule 10CFR50.62," dated December 1985.
4. Staff SER on BWROG Topical Report NEDE-31096-P. Letter from Gus Lainas (NRC) to Terry A. Pickens (BWR Owners' Group Chairman), dated October 21, 1986.

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