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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 151 TO FACILITY OPERATING LICENSE NO. DPR-49

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

DUANE ARNOLD ENERGY CENTER

DOCKET NO. 50-331

1.0 INTRODUCTION

On July 26, 1984, Title 10 of 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" (know 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 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.

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 devices. 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 weight percent 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.

By letters dated February 26, June 1, July 10 and November 13, 1987 (Refs. 1, 2, 3, & 4), Iowa Electric Light and Power Company (the licensee) provided information to comply with the ATWS Rule. This safety evaluation addresses the licensee's proposed implementation of the ATWS Rule requirements.

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, this equipment is part of the broader class of structures, systems, and components important to safety defined in the introduction to 10 CFR Part 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 "Considerations Regarding System 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 DUANE ARNOLD ARI & ATWS/RPT SYSTEM DESCRIPTION

The Duane Arnold Energy Center (DAEC) has installed a redundant ARI/RPT initiation logic system to mitigate the potential consequences of an anticipated transient without scram event. The system consists of reactor pressure and reactor water level sensors, logic, power supplies and instrumentation that is independent from the reactor trip system. It is a two divisional safety-related system. Each division is capable of initiating protective actions when both input channels (either pressure or level) within a division are tripped. The ARI/RPT system output will energize the devices to start the protective actions. The system can be manually initiated by depressing two pushbuttons simultaneously on the control panel. The ARI logic will cause the immediate energization of the ARI valves when either the reactor vessel high pressure trip setpoint or the low-low water level trip setpoint is reached.

The same logic will also trip the reactor coolant recirculation pumps. There are two breakers in series at each pump power feeder. Each logic train signal will trip one of the two breakers. Either logic train will trip both pumps.

The DAEC RPT logic delays recirculation pump trip on low-low water level for 9 seconds to allow the low-pressure coolant injection (LPCI) system loop selection

logic to complete its function. This function is detection of recirculation line break and selection of the LPCI injection point. No time delay is provided on a high reactor pressure vessel (RPV) pressure signal.

4.0 EVALUATION

The licensee participated in the BWR Owners Group ATWS implementation alternatives program. The BWR Owners Group submitted a licensing topical report, NEDE-31096-P, "Anticipated Transients Without Scram, Response to NRC ATWS Rule 10 CFR 50.62" (Ref. 5) for staff review. The staff accepted the topical report in Reference 6. Reference 1 summarizes the licensee's compliance with the ATWS Rule. The staff's evaluation is addressed in the following sections.

ARI

In a letter dated June 1, 1987 (Ref. 2), the licensee stated that, based on in-plant test data, the rod motion actually begins at approximately 10 seconds for the first rod and 30 seconds for the last rod. All rod motions will be completed within 37 seconds. A post-test evaluation determined that a choked flow condition exists in the scram valves for the individual control rod drives and that modifications to the design of the ARI system would not improve ARI performance.

The licensee requested General Electric to evaluate the test data. General Electric evaluated these data and concluded that, although the observed 30-second time delay is larger than that used in Reference 5, the design objectives would still be met as long as rod motion was completed within 60 seconds. The ATWS licensing topical report also recognizes that an important reason for minimizing the rod motion completion time is to ensure that the scram discharge volumes (SDV's) have sufficient volume to accommodate whatever leakage will occur during the time when the air header is bleeding down and rod motion has not begun. The test results indicate that sufficient volume exists in the DAEC SDV's to allow all control rods to complete their motion. The staff has evaluated the licensee's justification and concluded that the ARI system function time at the DAEC is acceptable.

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 Duane Arnold (DAEC) ARI/RPT logic provides signals for Alternate Rod Injection and the recirculation pump trip. It is designed as a Class 1E system. The ARI/RPT logic is totally independent from the existing reactor protection system except for annunciators. Contact isolation is provided between the annunciator and the initiation circuitry. Any failure in the annunciator system will not cause an ARI/RPT logic failure or prevent the existing reactor trip system (RTS) from performing its protective functions. The staff finds this acceptable.

The licensee stated that the ARI system has redundant valves at the scram air header. The ARI system performs a function redundant to the backup scram system and the RPS. The staff finds this acceptable.

The licensee stated that the ARI system is diverse and independent from the reactor trip system up to the scram air header. The ARI solenoid valves are DC powered with the solenoid valves energized to open. The ARI solenoid valves are separated from the backup scram valves. All instrument channel components, including the sensors, will be diverse from the existing RTS components. The staff finds this acceptable.

The licensee stated that the ARI actuation logic is separated from the RTS logic. The ARI/RPT system is electrically independent from the existing RTS. The staff finds this acceptable.

The licensee stated that the ARI system is physically separated from the RTS. Wiring for the RTS outside of the enclosures in the control room is run in rigid metallic conduits. All RTS conduits are identified by an alpha-numeric designator. The ARI/RPT system wiring uses scheduled cables and raceways. The ARI/RPT cable routing does not violate the DAEC RTS channel separation criteria. DAEC Quality Control personnel verified that the cables were installed as designed. The staff finds this acceptable.

The licensee stated that all hardware required for the ARI system to function will be environmentally qualified to conditions that occur during an anticipated operational occurrence. The staff finds this acceptable.

The licensee has committed to comply with Generic Letter 85-06, "Quality Assurance Guidance for ATWS Equipment That is Not Safety-Related." The staff finds this acceptable.

The licensee stated that the ARI logic is classified as safety-related and is powered from divisional 125 Vdc batteries. The noninterruptible power sources allow the ARI to perform its intended function during any loss of offsite power event. Circuit breakers are provided at the dc distribution panels that protect the ARI/RPT feeders. The ARI/RPT logic trains and RPT breaker trip coils are individually fused. The staff finds this acceptable.

The licensee stated that the ARI system will be testable up to and including the final actuating devices while the reactor is at power. The ARI system is comprised of two identical logic trains. Each logic train is equipped with an ARI solenoid valve. During the ARI surveillance test, a mode switch is set to the test position, which will block the ARI solenoid valve from being energized on one train. The other train still can be initiated by the automatic signals. The mode switch in the test position will not affect the manual initiation capability of the ATWS system. The staff finds this acceptable.

The licensee stated that the ARI design will utilize coincident logic. Both channels must be tripped in order to initiate the mitigative actions. The ARI actuation setpoints will not challenge scram setpoints. The staff finds this acceptable.

The licensee stated that manual initiation capability will be provided. The staff finds this acceptable.

The licensee stated that indication will be provided to indicate when the system is actuated, in test, or out of service. Four annunciators will be provided. They are:

1. ATWS Channel A Initiated
2. ATWS Channel B Initiated
3. ATWS Channel A in Test
4. ATWS Channel B in Test

The staff finds this acceptable.

The licensee stated that the ARI design will have a seal-in feature to ensure the completion of protective action once it is initiated. After removal of the initiating signal, the logic will automatically reset after a preset time delay to allow manual scram. The staff finds this acceptable.

As stated in Reference 6, the staff SE on GE Topical Report NEDE-31096-P, the staff does not intend to repeat its review of the design information described in the GE Topical Report and found acceptable when the report appears as a reference in a specific license amendment application. Reference 1 summarizes the licensee's compliance with the ATWS Rule. The staff finds that the Duane Arnold ARI design is in general compliance with the ATWS Rule, 10 CFR 50.62 paragraph (c)(3). The proposed Technical Specification changes associated with the ARI system are, therefore, acceptable.

STANDBY LIQUID CONTROL SYSTEM (SLCS)

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. 5) and approved in the NRC safety evaluation (Ref. 6), the licensee has chosen to use the combined options of dual pump operation at 52.4 gpm and an increased minimum sodium pentaborate solution concentration from 9.8 to 11.8 weight percent. In Reference 3, the licensee calculated a minimum required concentration of 11.2 weight percent sodium pentaborate for an injection rate of 52.4 pgm, assuming a total water mass of 329,909 lbs. in the reactor vessel and associated piping. The approach taken for the DAEC is consistent with that approved by the staff in Reference 6 and the resulting parameters are, therefore, acceptable.

The changed values lead to proposed Technical Specification changes. These include doubling the pump flow rate from 26.2 gpm for single pump operation to 52.4 gpm for dual pump operation in TS 3.4.1 and changing Figure 3.4-1 for the SLC solution concentration versus tank volume curve. The changes are necessary to reflect the new concentration limits which will ensure that the plant meets both the new ATWS requirements and the original SLC design requirements. The SLC design requirements are met using one pump based on the minimum flow rate of 26.2 gpm for one-pump operation. Also, Figure 3.4-2 is added to incorporate the

minimum solution temperature curve generated by adding 5°F margin instead of 10°F margin to the actual saturation temperature curve as described in the Basis 3.4.3. This is consistent with Final Safety Analysis Report Section 9.3.4.3 and acceptable. The licensee indicated that the Union Pump Co. (UPC) has tested and certified that net positive suction head requirements are satisfied and that vibration readings were well within acceptable levels for two-pump operation (Ref. 7). The associated Basis 3.4 has also been changed to reflect the revised approach and requirements. The staff finds that the licensee's approach meets the requirements of 10 CFR 50.62, paragraph (c)(4), and is, therefore, acceptable.

ATWS/RPT SYSTEM

In Reference 1, the licensee stated that the present RPT system at Duane Arnold will be upgraded to the "Monticello" design which is described in Reference 5. The licensee has installed a combined ARI/RPT redundant trip division and will use redundant breakers at each recirculation pump power feeder. Each ATWS division will trip a separate breaker. Although these breakers are also used for the reactor protection system (RPS) End-of-Cycle (EOC) recirculation pump trip, the EOC breakers installed at the DAEC were purchased with two trip coils. The first trip coil is associated with the RPS EOC/RPT system. The second trip coil is associated with the ATWS/RPT system. There is no interconnecting wiring between the two trip coils.

As stated in Reference 6, the Monticello design is an acceptable reference ATWS/RPT design. The staff concludes that the Duane Arnold ATWS/RPT design is in compliance with the ATWS Rule, 10 CFR 50.62 paragraph (c)(5) and therefore, the associated Technical Specification changes are acceptable.

5.0 ENVIRONMENTAL CONSIDERATIONS

This amendment changes requirements with respect to installation or use of facility components located within the restricted area as defined in 10 CFR Part 20. The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations, and the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

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7.0 REFERENCES

1. Iowa Electric Light and Power Company letter, R. W. McGaughy to H. Denton, dated February 26, 1987.

2. Iowa Electric Light and Power Company letter, R. W. McGaughy to T. Murley, dated June 1, 1987.

3. Iowa Electric Light and Power Company letter, R. W. McGaughy to T. Murley, dated July 10, 1987.

4. Iowa Electric Light and Power Company letter, W. C. Rothert to T. Murley, dated November 13, 1987.

5. GE Topical Report NEDE-31096-P "Anticipated Transients Without Scram; Response to NRC ATWS Rule 10 CFR 50.62," dated December 1985.

6. Staff SER on GE Topical Report NEDE-31096-P. Letter from Gus Lainas (NRC) to Terry A. Pickens (BWR Owners Group Chairman), dated October 21, 1986.

7. "Duane Arnold Energy Center Standby Liquid Control Dual Pump Test Report," dated April 18, 1985, Union Pump Company, Battle Creek MI.