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USQ EVALUATION

Facility or Activity: Advanced Test Reactor (ATR)

USQ Evaluation No.: SE-2003-145 Revision No.: 0

Title of Proposed Action or New Information: ATR Firewater Supply System Modeling Issues

1. Indicate which type: Proposed Action: ☐ New Information: ☒

2. Describe the Proposed Action or New Information:

The Test Reactor Area (TRA) raw water and firewater systems supply water to various facilities including the emergency firewater injection system (EFIS), cooling tower, the demineralizer plant, miscellaneous cooling services, fire protection, and potable water services. See Figures 9.2-1 and 9.2-2 of the Advanced Test Reactor (ATR) Upgraded Final Safety Analysis Report (UFSAR) for simplified diagrams of the ATR raw water and firewater systems. Part of the raw water and firewater systems are safety related. The nonsafety-related portions of the supply system in these two figures are indicated by cross hatching in the UFSAR figures. In many places the safety-related and non-safety-related portions of the firewater system are separated by normally open valves.

Raw water is drawn from three deepwells located along the north perimeter of the TRA by pumps that discharge into three 500,000-gal ground-level storage tanks. Water from the three 500,000-gal tanks supplies four feedwater pumps, one electric- and two diesel-powered firewater pumps, and the two ATR cooling tower makeup pumps. The feedwater pumps supply the 150,000-gal overhead storage tank.

The 150,000-gal overhead storage tank supplies water to the plant demineralizer, the firewater loop, and the TRA raw water distribution system. The TRA raw water distribution system supplies the various TRA facilities, including the ATR. Potable water is separated from the raw water downstream of the overhead storage tank and backflow from the raw water downstream of the potable water take out is prevented by check valves.

The firewater system, normally on open supply from the 150,000 gal overhead storage tank, is supplemented by one electric-powered and two diesel firewater pumps. The firewater pumps automatically start on low pressure. Varied pressure setpoints and time delays are used to avoid simultaneous starting of all three pumps. The fire loop supplies the yard irrigation systems and the EFIS for the ATR reactor, in addition to fire protection and suppression functions.

The EFIS water flow rate into reactor vessel is an important parameter in the loss-of-coolant accident analyses. The EFIS flow rate model used in the ATR UFSAR is described in EDF-TRA-ATR-1460. This simple model uses input pressures from various locations in the firewater supply system along with empirically based flow coefficients (pressure loss vs. flow rate) for the firewater supply system piping. The model determines the flow rate into the reactor vessel as a function of reactor vessel pressure. The analysis in EDF-TRA-ATR-1460 used the model to predict EFIS flow rates for various steady-state conditions in the firewater supply system. The EDF recommended using flow rate vs. reactor vessel pressure data for a case where the pressure at the firewater pump outlet was 63 psig. This is the minimum pressure setpoint for auto start of the first firewater pump and is the head pressure provided by the overhead tank when the tank is essentially empty (water in the stand-pipe only).

The model did not consider the normal usage flow demands on the system. For the assumed condition, these other demands would compete with the EFIS demand potentially lowering the flow rate to the reactor vessel. Typical normal usage flow rates are on the order of 800 gpm. This condition could exist until a firewater pump starts. The model thus under-predicts flow to the reactor vessel for the initial part of the EFIS actuation for the firewater supply system specified. Once a firewater pump starts the closing of a check valve isolates the overhead tank from the firewater system. Most of these demands are isolated from the firewater supply by the closing of the check valve, however, fire suppression and some yard irrigation demands still compete with reactor vessel flow.

The pump-start circuits include time delays that stagger pump starts to avoid severe water hammer effects. The first pump start is delayed 5 seconds after the low-pressure setpoint (i.e., 63 psig) is reached. The second pump is delayed 15 seconds and the third pump is delayed 25 seconds. EFIS flow into the reactor vessel predicted from the model is about 1800 gpm with the reactor vessel pressure at the actuation setpoint. For the condition specified in the model analysis, the overhead tank must provide the total flow rate (EFIS flow plus normal usage flow) until the pump starts and spins up to speed. Since the overhead tank could be empty when the pump start

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setpoint is reached, there is no water volume to provide this flow rate. Firewater system pressure and flow rate would continue to drop until the pump starts and provides flow. During this pump start time, the model again under-predicts flow to the reactor vessel for the steady-state condition specified.

This issues was previously identified in USQ screen SES-2003-460.

3. Identify applicable section(s) of the safety basis document(s) (i.e., SAR, BIO, TSRs, OSRs):

ATR UFSAR Chapter 9, Auxilliary Systems, Revision 11, April 28, 2003
ATR UFSAR Chapter 6, Engineered Safety Features,Revision 11, April 28, 2003
ATR UFSAR Chapter 15, Accident Analyses, Revision 11, April 28, 2003

4. Identify applicable procedural, operating, design, or technical document or criterion (including drawings, diagrams, schematics, etc.):

S. A. Atkinson, ATR EFIS and Firewater Flow vs. Vessel Upper Plenum Pressure and Firewater Supply System State, EDF-TRA-ATR-1460, April 1999.
SE-2003-126, Emergency Firewater Injection System Time Delay, September 2003

5. Identify applicable safety or operating function:

The firewater supply system provides the water supply for the ATR EFIS for accident mitigation.

6. Identify applicable operating condition:

The firewater supply system is required to be operable for accident mitigation when there are irradiated fuel elements in the reactor vessel. Automatic operation of the EFIS is required during the reactor operation, low power operation, and pressurized standby operating modes.

7. Identify applicable hazard, failure mode, or accident or malfunction of equipment important to safety evaluated in the safety basis, together with mitigating action or function:

USQ evaluation SE-2003-126 identified two design basis accidents sequences where delays in EFIS injection was adverse to the consequences. These were the 3-inch LOCA with failure of the LOCA pump shutoff engineered safety feature and the 3-inch LOCA with failure of one primary coolant check valve. The sensitivity of accident consequences to EFIS flow rate has not been investigated. It is expected that significantly lower EFIS flow rates would have adverse effect on consequences.

Firewater system failures are considered in Section 15.11.10 of the ATR UFSAR. These failures are not considered in conjunction with the reactor accident sequences. The UFSAR flow model includes an assumed failure of one of the EFIS actuation valves but does not consider failure of a firewater pump to start.

Failures in the non-safety-related portion of the firewater system could have an adverse effect on the capability of the firewater system to provide the assumed flow rates to the EFIS.

PART I: POTENTIAL FOR AN INCREASE IN PROBABILITY OR CONSEQUENCE OF AN ACCIDENT OR MALFUNCTION EVALUATED IN THE SAFETY BASIS

1. Could the Proposed Action or New Information increase the probability of occurrence of an accident previously Evaluated in the safety basis? Yes ☐ No ☒

Explain:

The new information concerning the potential under-prediction of emergency firewater injection into the reactor vessel does not indicate an increase in the probability of occurence of an accident previously evaluated in the safety basis. The firewater supply system provides a mitigation function. Failure or under-performance of the firewater system does not initiate an accident.

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2. Could the Proposed Action or New Information increase the consequences of an accident previously evaluated in the safety basis? Yes ☒ No ☐

   Explain:

   Failure or under-performance of the firewater supply system could increase the consequences of loss of coolant accidents analyzed in the safety basis. These accidents are mitigated by firewater injection. Low flow rates or time delays would tend to decrease the thermal hydraulic margins particularly for the seismic LOCAs.

3. Could the Proposed Action or New information increase the probability of occurrence of a malfunction of equipment Important to safety previously evaluated in the safety basis? Yes ☐ No ☒

   Explain:

   The probability of the firewater system malfunctions evaluated in the safety basis is not changed by the new information.

4. Could the Proposed Action or New Information increase the consequences of a malfunction of equipment important to safety previously evaluated in the safety basis? Yes ☒ No ☐

   Explain:

   Firewater system failures are considered in Section 15.11.10 of the ATR UFSAR. None of the failures considered address the effects of reduced flow rate or time delay to restore flow rate when EFIS is called upon to mitigate a LOCA. While the UFSAR flow model includes an assumed failure of one of the EFIS actuation valves, failure of a pump to start, is not considered. Failure of the first pump to start would result in additional time delays and lower flow rates until the second pump started. As noted above additional time delays and lower flow rates can adversely effect the accident consequences. The consequences of failures outside of the safety-related boundary are not addressed in the safety basis. Such a failure could reduce the firewater flow rate delivered to the EFIS.

PART II: POTENTIAL FOR CREATION OF AN UNANALYZED ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE

5. Could the Proposed Action or New Information create the possibility of an accident of a different type than previously evaluated in the safety basis? Yes ☐ No ☒

   Explain:

   The new information concerning the potential under-prediction of emergency firewater injection into the reactor vessel does not indicate the possibility of an accident of a different type than previously evaluated in the safety basis. The firewater supply system provides a mitigation function. Failure or under-performance of the firewater system does not initiate an accident.

6. Could the Proposed Action or New Information create the possibility of a malfunction of equipment important to safety of a different type than previously evaluated in the safety basis? Yes ☒ No ☐

   Explain:

   The new information does indicate there are performance issues and potential signifianct failure modes that are not addressed in the safety basis. Flow reductions due to flow diversions, insufficient pressure, and pump start failures are not adequately addressed in the safety basis.

PART III: POTENTIAL FOR REDUCTION IN A MARGIN OF SAFETY

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7. Could the Proposed Action or New Information reduce a margin of safety as defined in the safety basis?
   Yes ☒ No ☐

   Explain:
   The margins of safety are defined in the safety basis by the ATR plant protection criteria (e.g., 3σ to critical heat flux for Condition 2 events). The new information does not affect those definitions, however, under-performance of the EFIS could result in a decrease in the margins of safety as evaluated in the safety basis.

PART IV: USQ EVALUATION CONCLUSION

Based on the evaluations in Part I, Part II, and Part III, does the Proposed Action or New Information involve an Unreviewed Safety Question? Yes ☒ No ☐

Explain:

R. T. McCracken USQ Evaluator (Typed Name)	R. T. McCracken USQ Evaluator (Signature)	11-10-03 Date
G.L. Sharp *Independent Review – USQ Evaluator (Optional with Facility Manager) (Typed Name)	*Independent Review – USQ Evaluator (Optional with Facility Manager) (Signature)	11-10-03 Date
D. W. Suthers Approval / Facility Manager (Typed Name)	Approval / Facility Manager (Signature)	11/10/03 Date
A. P. Hoskins Concurrence – ISRC Committee Chair (Typed Name)	Concurrence – ISRC Committee Chair (Signature)	11/10/03 Date

* USQ Evaluator Independent Review may be performed by ISRC Chair.

PART V: NOTIFICATION FOR ORPS REPORTING (SEE MCP-190; NEW INFORMATION CASES ONLY)

D. W. Suthers Facility Manager / Plant Shift Supervisor (Typed Name)	Facility Manager / Plant Shift Supervisor (Signature)	11/10/03 Date