INL USQ PROCESS
REASONABILITY DETERMINATION/POTENTIAL INADEQUACY IN THE SAFETY ANALYSIS (PISA) FORM
(DO NOT USE FOR PROPOSED CHANGES)

Facility or Activity: Advanced Test Reactor

USQ Process No.: RTC-USQ-2008-137

Subject: Response Time and Safety Rod Drop Time Modeling and Requirements Discrepancy for NI Scram Functions

Describe the New Information/Discovery:

The RELAP modeling of the response times and safety drop times is not consistent with the release times and safety rod drop times required by TSR-186. The discrepancy can result in an allowed safety rod insertion that is 3 ms (6 ms for depressurized operation) greater than that assumed in the accident analysis. The accuracy associated with safety rod response time, release time, and drop time measurements will also contribute to a potential increase of 2 ms in the measured times. TSR-186 establishes the actuation response time requirements in Sections 3.1.1 and 3.7.1 for 2 primary coolant pump (PCP) pressurized operation, 3 PCP pressurized operation, and depressurized operation.

The response time from initiation of the protective function until the safety rods are inserted includes the delay times for:

- neutron flux measurement instrumentation,
- release time (de-energizing the rod clutch coil controllers (RCCC) and collapse of the magnetic field (i.e., RCCC release time)), and
- safety rod insertion for the first 12 inches of rod travel.

The response time requirement defined in TSR-186 Section 3.1.1 includes the combined neutron flux measurement instrumentation time and RCCC release time. The safety rod drop time requirement in TSR-186 Section 3.7.1 includes the combined RCCC release time and the safety rod insertion time.

In summary, the subject of this potential inadequacy in safety analysis (PISA) is a discrepancy between the safety analysis response time/safety rod insertion time modeling in the Reactor Excursion and Leak Analysis Program (RELAP) and the TSR requirements. The RELAP modeling and the TSR requirements do not consistently incorporate the portion of the response time corresponding to the neutron flux measurement instrumentation. In addition, the requirements do not account for uncertainty in the test measurement equipment and process associated with the time response testing. Additional detail is provided in the discussion below.

For 2 PCP pressurized operation TSR-186 Section 3.7.1 requires the RCCC release time to be ≤22 ms and the drop time to be ≤170 ms. For 3 PCP pressurized operation TSR-186 Section 3.7.1 requires the RCCC release time to be ≤22 ms and the drop time to be ≤150 ms.
The safety rod drop time corresponds to the safety rods having inserted 12 inches and includes the ≤22-ms RCCC release time. Surveillance testing performed through DOP-7.1.9 ensures that both the TSR release time requirement (≤22 ms) and the drop time requirements (≤170 ms or ≤150 ms) are met.

The RELAP modeling bounds a total actuation response time and safety rod insertion time for the neutron level scram functions of ≤ 170 ms and ≤ 150 ms for 2 PCP and 3 PCP operations, respectively. RELAP models a ≤ 25 ms response time (prior to safety rod release) with the balance of the time (i.e., ≤ 125 ms or ≤ 145 ms) available for safety rod insertion of 12 inches. The ≤ 25 ms response time includes 3 ms corresponding to the neutron flux measurement instrumentation and ≤ 22 ms corresponding to the RCCC release time. The RCCC release time is included in the requirements of TSR-186 Section 3.1.1 and Section 3.7.1.
Hence, RELAP models, for 3 PCP operation, a total time of 150 ms:

- nuclear instrument response (3 ms),
- RCCC release (≤ 22 ms), and
- safety rod insertion of 12 inches (≤ ~~145~~ 125 ms). GLS 3/11/08

The RELAP model also bounds a safety rod insertion time for 2 PCP operations with a ≤ 145 ms safety rod insertion time.

The ≤ 25-ms response time is required through TSR-186 Section 3.1.1 and is verified by surveillance testing through DOP-2.6.55 " RSS Neutron Level Subsystem Response Time Test Channels A, B and C" DOP-2.6.61

INL USQ PROCESS
REASONABILITY DETERMINATION/POTENTIAL INADEQUACY IN THE SAFETY ANALYSIS (PISA) FORM
(DO NOT USE FOR PROPOSED CHANGES)

Facility or Activity: Advanced Test Reactor

USQ Process No.: RTC-USQ-2008-137

Subject: Response Time and Safety Rod Drop Time Modeling and Requirements Discrepancy for NI Scram Functions

"RSS Wide Range Neutron Subsystem Response Time Test Channels A, B, and C", and DOP-7.1.9 "Safety Rod Release And Drop Times Measurement."

The safety rod drop time requirements in TSR-186 Section 3.7.1 do not correctly incorporate the additional 3-ms delay associated with the nuclear instrument that is considered in the total ≤170-ms (or ≤150-ms) time modeled in RELAP. As a result, the safety rod drop time TSR-186 requirements allow for an additional 3 ms in the safety rod drop time than assumed in the RELAP modeling.

In addition to this 3 ms discrepancy in the safety rod drop time requirements, the time response requirements and measurements do not account for uncertainty in the test measurement equipment and process associated with the time response testing. This may result in the actual RCCC release time being up to 2 ms greater than measured. The RCCC release time measurement uncertainty potentially impacts the neutron level and wide range neutron level response time measurements and verification that the response times are within the requirements of TSR-186 Table 3.1.1-1. The potential measurement uncertainty for the neutron flux measurement instrumentation response time is not significant compared to the release time measurement accuracy.

A ≤35-ms response time is modeled followed by a ≤265-ms time for safety rod insertion for depressurized operation. The safety rod release time (≤29 ms) and drop time (≤300 ms) are defined in TSR-186 Section 3.7.1. Hence, the safety rod drop time does not account for the additional 6 ms associated with the response of the nuclear instruments. Note that there is no scheduled operation with the ATR in the depressurized operation mode. Plant procedures governing depressurized operation had been previously suspended.

Identify the applicable safety basis document(s) (e. g., DSA, SAR, BIO, TSRs, etc.):

SAR-153, Upgraded Final Safety Analysis Report for the Advanced Test Reactor
TSR-186, Technical Safety Requirements for the Advanced Test Reactor

I. **REASONABILITY DETERMINATION (Reasonability determinations made as part of the ATR Design Basis Reconstitution effort may be documented per SP-10.2.4.9)**

Is it reasonable that the potential for an inadequate safety analysis exists based on the new information or discovery described above? ☒ Yes ☐ No

If "Yes," proceed to Sections II, III, and IV.
If "No," provide an explanation and basis for the reasonability determination.

N/A USQ Evaluator Print/Type Name	USQ Evaluator Signature	Date
N/A Nuclear Facility Manager Print/Type Name	Nuclear Facility Manager Signature	Date

If the answer to the question above is "No," file the completed form. Do not complete Section II, III, or IV.

If the answer to the question above is "Yes," complete Section II, III, and IV.

INL USQ PROCESS
REASONABILITY DETERMINATION/POTENTIAL INADEQUACY IN THE SAFETY ANALYSIS (PISA) FORM
(DO NOT USE FOR PROPOSED CHANGES)

Facility or Activity: Advanced Test Reactor

USQ Process No.: RTC-USQ-2008-137

Subject: Response Time and Safety Rod Drop Time Modeling and Requirements Discrepancy for NI Scram Functions

II. PISA DECLARATION

What is the basis for concern that the safety basis may not be bounding or may be otherwise inadequate? Provide an explanation.

The RELAP modeling of the response times and safety drop times is not consistent with the release times and safety rod drop times required by the TSR. The discrepancy can result in an allowed safety rod insertion that is 3 ms (6 ms for depressurized operation) greater than that assumed in the accident analysis. The accuracy associated with safety rod response time, release time, and drop time measurements will also contribute to a potential increase of 2 ms in the measured times.

A PISA exists. Complete the following actions

- Nuclear Facility Manager document actions (below) including interim operating restrictions taken to place or maintain the facility in a safe condition.
- Nuclear Facility Manager execute reporting process for PISA per LWP-9301 and LWP-13830.
- Qualified USQ evaluator proceed to Section III.

ACTIONS TAKEN TO PLACE OR MAINTAIN FACILITY IN A SAFE CONDITION AND THE BASIS FOR THE SELECTION OF ANY INTERIM CONTROLS.

The ATR is currently operating with 2 PCPs. The TSR-186 Section 3.7.1 safety rod drop time requirement is ≤ 170 ms for this operating configuration. The 3 ms discrepancy discussed above can be conservatively applied to the drop time limit. Additionally, the equipment and process for performing safety rod release time and drop time testing have been reviewed and is judged to have an accuracy that is ≤2 ms. Therefore, the maximum measured drop time shall not exceed 165 ms and the RCCC release time shall not exceed 20 ms in order to establish that the required safety function can be accomplished. The safety rod drop test data for the current operating cycle was also reviewed and identified that the maximum drop time for all safety rods was 163 ms and the maximum RCCC release time was 18 ms. The 2-ms accuracy associate with the RCCC release time measurement is included in the response time requirements in TSR-186 Section 3.1.1. Hence, the accident analysis response time requirements also continue to be met. Therefore, for the current operating cycle, the response time and safety rod drop times are within the assumptions of the accident analysis.

In addition to establishing that the current nuclear instrumentation scram actuations and safety rod insertions can be accomplished within the time response assumptions of the safety analysis, the current cycle reactor power level is well below the analyzed value. This provides additional assurance that current operation is within the bounding accident analysis.

Therefore, ATR operation, in the current operating cycle, is within the safety basis and no immediate actions are necessary to place the facility in a safety condition.

Interim controls are imposed in order to ensure that ATR operating conditions remain within the assumptions of the accident analysis. The following nuclear instrument scram actuation response time, RCCC release time, and safety rod drop time limits must be met in order to ensure operability. These values are more restrictive than those defined in TSR-186 Sections 3.1.1 and 3.7.1.

The TSR Section 3.1.1 (Table 3.1.1-1) response times are reduced by 2 ms to account for uncertainty in the RCCC release time measurement.

INL USQ PROCESS
REASONABILITY DETERMINATION/POTENTIAL INADEQUACY IN THE SAFETY ANALYSIS (PISA) FORM
(DO NOT USE FOR PROPOSED CHANGES)

Facility or Activity: Advanced Test Reactor

USQ Process No.: RTC-USQ-2008-137

Subject: Response Time and Safety Rod Drop Time Modeling and Requirements Discrepancy for NI Scram Functions

Parameter	Applicability	Response Time
Neutron Level	Power Operation Low Power Operation	≤0.023 Seconds
	Depressurized Operation	≤0.033 Seconds
Wide Range Neutron Level	Power Operation Low Power Operation	≤0.023 Seconds (top 2 decades) ≤0.033 Seconds (for all other decades)
	Depressurized Operation	≤0.033 Seconds

The TSR Section 3.7.1 (Table 3.7.1-1) release times are reduced by 2 ms to account for uncertainty in the RCCC release time measurement. The drop times are reduced by 5 ms for pressurized operation and 8 ms for depressurized operation to account for uncertainty in the RCCC release time measurement (2 ms) and the discrepancy in the release time requirement (3 ms pressurized, 6 ms depressurized).

Applicability	Release Time	Drop Time (Note 1)
Depressurized Operation	≤27 ms	≤292 ms
Power Operation (2-PCP) Low Power Operation (2-PCP	≤20 ms	≤165 ms
Power Operation (3-PCP) Low Power Operation (3-PCP	≤20 ms	≤145 ms
Note 1: As identified in TSR-186 Section 3.7.1, the safety rod release time is included in the drop time.		

G. L. Sharp Safety Analyst Print/Type Name	Safety Analyst Signature	2/28/08 Date
M. B. McDonough Nuclear Facility Manager Print/Type Name	Nuclear Facility Manager Signature	2/28/08 Date

Is independent technical review required? Yes ☐ No ☒

Nuclear Facility Manager
Signature or Initials

Independent Reviewer Print/Type Name	Independent Reviewer Signature	Date

INL USQ PROCESS
REASONABILITY DETERMINATION/POTENTIAL INADEQUACY IN THE SAFETY ANALYSIS (PISA) FORM
(DO NOT USE FOR PROPOSED CHANGES)

III. USQ DETERMINATION

Identify applicable section(s) of the safety basis document(s) (e.g., DSA, SAR, BIO, TSRs, etc.).

SAR-153, Chapter 15 and Chapter 16
TSR-186, Sections 3.1.1 and 3.7.1

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

1. Could the PISA increase probability of occurrence of an accident previously evaluated in the safety basis?
Yes ☐ No ☒
Explain:

The identified discrepancies between the neutron flux measurement instrumentation response times, RCCC release times, and safety rod drop times modeled in the analysis and the requirements for these times established in TSR-186 correspond to mitigation of postulated accidents. The response time, RCCC release time, and safety rod drop times do not contribute to initiation of postulated accidents. Hence, there is no increase in the probability of occurrence of an accident previously evaluated in the safety basis.

2. Could the PISA increase the consequences of an accident previously evaluated in the safety basis?
Yes ☒ No ☐
Explain:

The neutron flux measurement instrumentation response time, RCCC release time, and safety rod drop time requirements in TSR-186 do not ensure the conditions modeled in the accident analysis. That is, the RELAP analysis assumptions may not bound actual system performance. Note that the RELAP analyses model the safety rod drop time as a negative reactivity insertion (due to safety rod insertion) versus time. The reactivity insertion model includes sufficient conservatism to likely bound a 3 ms discrepancy (6 ms for depressurized operation) in the safety rod drop time discussed above. However, the model does not likely include sufficient conservatism to offset a potential 2-ms increase in the RCCC release time, due to the measurement uncertainty, prior to release of the safety rods. The discrepancy may result in a delay in initial safety rod (reactivity) insertion, compared to the analysis reactivity insertion model, resulting in a potential increase in the calculated consequence for some analyzed accidents.

3. Could the PISA increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the safety basis? Yes ☐ No ☒
Explain:

The identified discrepancies between the neutron flux measurement instrumentation response times, RCCC release times, and safety rod drop times modeled in the analysis and the requirements for these times established in TSR-186 correspond to mitigation of postulated accidents. The response time, RCCC release time, and safety rod drop time requirements do not contribute to potential equipment malfunctions. Hence, there is no increase in the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the safety basis.

4. Could the PISA increase the consequences of a malfunction of equipment important to safety previously evaluated in the safety basis? Yes ☒ No ☐
Explain:

Postulated accidents analyzed in the ATR SAR may be initiated through malfunction of important-to-safety equipment, and subsequently rely on reactor scram actuated by the neutron flux measurement instrumentation. As discussed above (see question 2), the TSR-186 requirements do not ensure the conditions modeled in the accident analysis are bounding. Therefore, the discrepancy in the response time, RCCC release time, and safety rod drop time requirements may result in an increase in the consequences due to a malfunction of equipment important to safety.

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

INL USQ PROCESS
REASONABILITY DETERMINATION/POTENTIAL INADEQUACY IN THE SAFETY ANALYSIS (PISA) FORM
(DO NOT USE FOR PROPOSED CHANGES)

5. Could the PISA create the possibility of an accident of a different type than previously evaluated in the safety basis? Yes ☐ No ☒

   Explain:

   The identified discrepancies between the neutron flux measurement instrumentation response times, RCCC release times, and safety rod drop times modeled in the analysis and the requirements for these times established in TSR-186 correspond to mitigation of postulated accidents. These modeling assumption and requirements do not contribute to initiation of postulated accidents, nor do they create the possibility of a different type of accident. Hence, the discrepancy does not create the possibility of an accident of a different type than previously evaluated.

6. Could the PISA 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 identified discrepancies between the neutron flux measurement instrumentation response times, RCCC release times, and safety rod drop times modeled in the analysis and the requirements for these times established in TSR-186 correspond to mitigation of postulated accidents. These modeling assumptions and requirements do not contribute to potential equipment malfunctions. Hence, the discrepancy does not create the possibility of a malfunction of equipment important to safety previously evaluated in the safety basis.

IIIc: POTENTIAL FOR REDUCTION IN A MARGIN OF SAFETY

7. Could the PISA reduce a margin of safety as defined in the safety basis? Yes ☒ No ☐

   Explain:

   The neutron flux measurement instrumentation response time, RCCC release time, and safety rod drop time requirements in TSR-186 do not ensure the conditions modeled in the accident analysis are bounding (see question 2). Therefore, the discrepancy in the between the analysis models and TSR-186 requirements may result in an increase in the calculated consequence for some analyzed accidents. The discrepancy may, therefore, result in a decrease in the margin of safety.

IIId: USQ DETERMINATION CONCLUSION

8. Based on the responses to questions 1 – 7 above, does the PISA constitute an Unreviewed Safety Question? Yes ☒ No ☐

   Explain: See above.

   If "No," is a Safety Basis document revision required at next annual update? ☐ Yes ☐ No

   NOTE: If USQ determination result is positive, additional notification for ORPS is required per LWP-9301.

IV. APPROVAL/CONCURRENCE SIGNATURES

APPROVAL:

G. L. Sharp	[signature]	3/11/2008
USQ Evaluator Print/Type Name	USQ Evaluator Signature	Date
M. B. McDONOUGH	M. B. McDonough	3/11/2008
Nuclear Facility Manager Print/Type Name	Nuclear Facility Manager Signature	Date

CONCURRENCE:

Alan P Hoskins	Alan P Hoskins	3-11-08
Independent Review Committee Chair Print/Type Name	Independent Review Committee Chair Signature	Date