

**REQUESTS FOR SUPPLEMENTAL INFORMATION TO SUPPORT THE TRISO-X
LICENSE APPLICATION**

Docket No. 70-7027; EPID: L-2022-NEW-0005

Table of Contents

1	GENERAL INFORMATION	1
1.1	RSI – (Exemptions)	1
2	INTEGRATED SAFETY ANALYSIS	2
2.1	RSI – (ISA)	2
2.2	RSI – (ISA)	3
2.3	RSI – (ISA)	3
2.4	RSI – (ISA)	4
2.5	RSI – (ISA)	4
2.6	RSI – (ISA)	5
2.7	Observation – (ISA)	6
3	CRITICALITY SAFETY	6
3.1	RSI – (Criticality)	6
3.2	Observation – (Criticality)	7
3.3	Observation – (Criticality)	7
4	CHEMICAL SAFETY	7
4.1	RSI – (Chemical)	7
4.2	RSI – (Chemical - Facility and Process Description)	8
4.3	RSI – (Chemical - Hazard Information)	9
4.4	RSI – (Chemical - Hazard Sequence Identification)	9
4.5	RSI – (Chemical - Consequence Assessment)	9
4.6	RSI – (Chemical - IROFS)	10
4.7	Observation – (Chemical)	10
5	FIRE SAFETY	11
5.1	RSI – (Fire)	11
5.2	RSI – (Fire)	12
5.3	RSI – (Fire)	12
5.4	RSI – (Fire)	13
5.5	Observation – (Fire)	14
6	STRUCTURAL DESIGN	14
6.1	RSI – (Structural 1)	14
6.2	RSI – (Structural 3.1)	15
6.3	RSI – (Structural 3.2)	16
6.4	RSI – (Structural 3.3)	16
6.5	RSI – (Structural 3.4)	17
6.6	RSI – (Structural 3.5)	17
7	GEOTECHNICAL INFORMATION	18
7.1	RSI – (Geotechnical)	18
7.2	RSI – (Geotechnical)	18
7.3	RSI – (Geotechnical)	18
7.4	RSI – (Geotechnical)	19
7.5	RSI – (Geotechnical)	19

Enclosure

7.6	RSI – (Geotechnical)	20
8	ELECTRICAL AND INSTRUMENTATION AND CONTROL	20
8.1	RSI – (Electrical, Instrumentation and Control)	20
9	HUMAN FACTORS	22
9.1	RSI – (Human Factors).....	22
10	PRINCIPLE CONTRIBUTORS.....	23

Requests For Supplemental Information for the TRISO-X License Application

The Requests for Supplemental Information (RSI) provided below identify the additional information the U.S. Nuclear Regulatory Commission (NRC) staff need to proceed with the acceptance review of the TRISO-X, LLC (TRISO-X) license application, ISA Summary, and supporting documentation (e.g. plans) dated April 5, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML22101A200). The RSIs consist of three parts: Supplemental Information Needed, Description of Issue, and Regulatory Basis. The Information Needed section identifies the information that is needed for the NRC staff to complete the acceptance review. The Description of Issue section summarizes why the current submittal needs revisions. The Regulatory Basis section identifies the applicable requirements in the Title 10 Code of Federal Regulation. The Regulatory Basis may also reference guidance such as NUREG-1520, Revision (Rev.) 2, “Standard Review Plan for Fuel Cycle Facilities License Applications” (Agencywide Documents Access and Management System Accession Number (No.) ML15176A258), which provides acceptance criteria that may be used as one acceptable approach to demonstrate compliance with the applicable regulations.

In addition to the RSIs, several Observations are also provided. The Observations are provided for awareness and are not needed to support the acceptance review. The response to an Observation is voluntary. The purpose of the Observations is to improve the efficiency of the review by allowing the NRC staff to request technical information that may reduce the need for a future request for additional information.

1 GENERAL INFORMATION

1.1 RSI – (Exemptions)

Supplemental Information Needed:

The license application section 1.3, “Special Exemptions and Special Authorizations,” contains several exemption requests. The following information is needed to proceed with the formal review of these exemption requests:

- **RSI 1-A – Exemptions for Criticality Monitoring:**
Provide a sufficient justification for exemption request 1.3.2 – “Criticality Monitoring” consistent with the applicable section(s) of the regulations (i.e., 10 CFR 70.17, “Specific Exemptions”).
- **RSI 1-B – Environmental Reviews for Exemption Requests:**
Provide the appropriate environmental determination and supporting analysis for each of the exemptions. This information can be provided in the license application or addressed in the environmental report. If the information is placed in the environmental report, provide a cross reference in the license application.
- **Observations:**
 - Modify the Special Exemptions and Special Authorizations section to make explicitly clear in the title (or some other means) which requests are exemptions and which are authorizations. Also, consider grouping the Special Authorizations together.

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- Clarify whether section 1.3.7 – “Release for Unrestricted Use” is an exemption request or a special authorization.
- Clarify what portion of the regulation is being requested for exemption in license application section 1.3.2, “Criticality Monitoring.”

Description of Issue:

Each exemption request provided in the application needs to address the regulatory criteria for exemptions and include an environmental review. The bulk of the criteria are addressed, but the following issues need to be resolved. The exemption request 1.3.2 – “Criticality Monitoring” needs to address the three criteria in 10 CFR 70.17 and the environmental requirements. The exemption request in 1.3.3 -- “Posting and Labeling,” 1.3.4 -- “ICRP-68 DAC and ALI Values,” 1.3.5 – “ICRP-60 Organ Dose Weighting Factors,” and 1.3.6 -- “Certain Unplanned Contamination Events” need to address the environmental requirements.

Regulatory Basis:

Exemption requests must demonstrate compliance with the criteria in the applicable portions of the regulations, which includes 10 CFR 20.2301, “Applications for exemptions” and 10 CFR 70.17, “Specific Exemptions.” In addition, exemptions are considered licensing actions and therefore also require an environmental evaluation consistent the requirements in 10 CFR 51 (e.g., 10 CFR 51.21, 10 CFR 51.22(c)(25)), and guidance in NUREG-1748 (Accession No ML032450279).

2 INTEGRATED SAFETY ANALYSIS

2.1 RSI – (ISA)

Supplemental Information Needed:

Provide descriptions of the initiating or enabling events and information to describe or explain the frequency scores for each initiating or enabling event and, where relevant, describe or explain the duration score for each accident sequence.

Description of Issue:

Tables 4-3.1 through 4-3.24 of the ISA Summary summarize sequences for the different hazard types (criticality, radiological, chemical, and fire). However, the accident sequences need descriptions of the initiator or enabling events, including descriptions that explain the frequency indices or, for the relevant sequences, duration indices. While the accident sequence has an identifying number and label, the ISA Summary needs to also provide information about the initiator and enabling events. Some sequences have multiple frequencies in the initiating/enabling event column, which would indicate multiple events are involved, but there should also be a description of these events. In some cases, the information is simply “see IROFS”, which is ambiguous and does not provide the necessary information about the initiating or enabling events.

If any accident sequences are intended to address events in multiple systems or processes, the sequence descriptions should include information to identify which systems or processes the sequence applies to and information to show what initiating and enabling events are being grouped together. For example, accident sequences in Table 4-3.24 of the ISA Summary identify accidents involving vessels or piping. With multiple systems having vessels or piping, there is not enough information to identify the

processes to which the accident sequence applies or evaluate the appropriateness of that combination of sequences into a single sequence.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(3), the ISA Summary must include a general description of the types of accident sequences analyzed in the ISA consistent with 10 CFR 70.62(c)(1)(iv). In addition, 10 CFR 70.65(b)(4) requires the ISA Summary provide sufficient information to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61,

2.2 RSI – (ISA)

Supplemental Information Needed:

Provide a description of the hazard identification and hazard analysis method(s) used and the bases for the selection of this method(s).

Description of Issue:

Section 5.3 of the ISA Summary includes a discussion about the considerations used to select the methods for performing the hazard identification and analyses. The staff recognizes that the applicant performed process hazard analyses. However, the ISA Summary does not describe the process hazard analysis method(s) that the applicant used or how it was used. Nor does it describe the bases for the method(s) selection and use.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(5), the ISA Summary needs to include a description of the methods used to perform the ISA. This includes a description of the methods used to analyze the relevant hazards identified in the ISA consistent with the requirements in 10 CFR 70.62(c)(1).

The guidance in section 3.4.3.2 of NUREG-1520, Revision 2, provides one possible method to demonstrate compliance with the regulations for the information to be incorporated into the ISA Summary. Section 3.4.3.2 (3) states that description of the process hazard analysis in the ISA Summary should demonstrate use of systematic methods for identification of general types of accident sequences. It provides additional guidance that an acceptable method of hazard identification and process hazard analysis is one that is used in accordance with the criteria of NUREG-1513, "Integrated Safety Analysis Guidance Document." Section 3.4.3.2 (5) provides criteria for acceptable process hazard analysis methods.

2.3 RSI – (ISA)

Supplemental Information Needed:

Provide descriptions of items relied on for safety (IROFS) that are sufficient to understand their functions in relation to the performance requirements in 10 CFR 70.61 and how they perform those functions.

Description of Issue:

While Section 6.1 of the ISA Summary provides tables of IROFS, the descriptions for many do not provide a clear understanding of their function or how they fulfill that function. [REDACTED] The descriptions should include a level of detail to understand how the IROFS function is performed and to evaluate its reliability and availability.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(6), the ISA Summary must include a list describing each IROFS in sufficient detail to understand their functions in relation to the performance requirements of 10 CFR 70.61. The description in the ISA Summary should be sufficient to demonstrate compliance with 10 CFR 70.62(c)(1), which requires that the applicant conduct and maintain an ISA that identifies each IROFS and the characteristics of its safety function.

2.4 RSI – (ISA)

Supplemental Information Needed:

Provide information regarding the proposed facility processes and systems that is sufficient to ensure an understanding of the theory of operation and the hazards identified for each process and system.

Description of Issue:

Section 3 of the ISA Summary identifies and includes descriptions of the facility systems and processes; however, the level of information does not appear to be sufficient to support an understanding of the operations of the processes and systems and the hazards associated with them. As described in NUREG-1520, Section 3.4.3.2 (3), the description would normally include items such as parameters to be controlled, materials and quantities needed to understand the hazards, and process safety limits and margins on variables, among others.

Some examples of information which the staff finds would be necessary to understand the operations[REDACTED] Also, there are various acronyms used for processes or components which need to be defined to clarify what process or component is being discussed.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(3), the ISA Summary must include a description of each process analyzed in the ISA in sufficient detail to understand the theory of operation, the hazards identified for each process, and the types of accident sequences. The description in the ISA Summary should be sufficient to demonstrate compliance with 10 CFR 70.62(c)(1), which requires the applicant to conduct an ISA of appropriate detail for the complexity of the process that identifies the relevant hazards, potential accident sequences, the consequences and likelihoods of the accidents, and the IROFS for those accidents.

2.5 RSI – (ISA)

Supplemental Information Needed:

Provide information that shows that accident sequences, including their likelihoods and consequences have been identified and evaluated for all relevant systems and processes.

Description of Issue:

The ISA Summary provides some tables that identify consequence categories for accidents for various processes and systems and some tables that identify the likelihoods that were evaluated for accident sequences and IROFS for various processes and systems. However, it is not clear that all relevant systems or processes

have been addressed. For example, it is not clear that there are nuclear criticality safety tables to address the final fuel form package area, R&D area, liquid recovery process, and dry recovery process. It is not clear what processes, systems, or areas that tables such as Tables 4-3.6, 4-3.15, 6-1.6, and 6-1.15 apply to. It is also not clear that the consequences tables (Tables 4-1.1 through 4-1.6 and Tables 4-2.1 through 4-2.7) and the accident sequences table, Table 4-3.24, address the same accidents or cover the same processes, systems, or areas. For example, the consequences tables identify numerous accidents with one identification scheme, but the accident sequence table uses another scheme and so appears to identify other accidents. Also, Table 4-3.24 does not identify the consequence category that is used in the final risk score nor the basis for that consequence category.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(3) the ISA Summary should provide a description of each process in sufficient detail to understand the theory of operation, the hazards that were identified pursuant to 10 CFR 70.62(c)(1), and the types of accident sequences. In accordance with 10 CFR 65(b)(4), the ISA Summary must include information demonstrating compliance with the 10 CFR 70.61 performance requirements.

2.6 RSI – (ISA)

Supplemental Information Needed:

Provide evaluations of unmitigated likelihoods and consequences and descriptions of the necessary IROFS for natural phenomena hazards.

Description of Issue:

While the application and ISA Summary discuss hazards like tornadoes and seismic events, other hazards should also be evaluated for the site. These events include frozen precipitation or ice storm events. With Figure 1-2 of the application, it appears that the site cuts into nearby hills or slopes, creating a potential for mud or debris slides from those hills. The application also describes evidence of sinkholes or depressions resulting from subterranean karsting. The ISA and ISA Summary should include evaluations of the likelihoods and consequences from such hazards, descriptions of the methods used for those evaluations, and descriptions of the IROFS, if any are needed, for such hazards.

Regulatory Basis:

In accordance with 10 CFR 70.62(c)(1)(iv)~(vi), the applicant must conduct and maintain an ISA that identifies potential accident sequences caused by natural phenomena, the consequences and likelihood of each accident sequence, and each IROFS identified per 10 CFR 70.61(e). In addition, 10 CFR 70.65(b)(4) the ISA Summary must include information that demonstrates the licensee's compliance with the performance requirements of § 70.61. In accordance with 10 CFR 70.65(b)(6), the ISA Summary must list each item relied on for safety which is identified pursuant to 10 CFR 70.61(e), with a brief description of each that provides sufficient detail to understand their functions in relation to the performance requirements of 10 CFR 70.61.

2.7 Observation – (ISA)

Additional Information Needed:

Provide definitions of unlikely and highly unlikely for criticality hazards and events, as well as unlikely for natural phenomena hazards and events, for the purposes of evaluating compliance with the performance requirements in 10 CFR 70.61.

Description of Issue:

One or more of the currently proposed definitions in Section 9 of the ISA Summary include language to indicate that they do not apply to criticality hazards or natural phenomena hazards. For natural phenomena hazards, for example, a separate definition is provided for highly unlikely than is used for other hazards and events. However, it is not clear whether or not the definition of unlikely is applied to these hazards and events or if some other definition is to be used. For criticality hazards, the definition of unlikely includes a statement to indicate that it does not apply to double contingency evaluations. Thus, it is not clear that the ISA provides definitions of unlikely and highly unlikely for evaluation of criticality hazards.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(9), the ISA Summary must include a description of the definitions of unlikely, highly unlikely, and credible that are used in the ISA analyses, which is needed to support evaluation of compliance with the performance requirements in 10 CFR 70.61 (b), (c) and (d).

3 CRITICALITY SAFETY

3.1 RSI – (Criticality)

Supplemental Information Needed:

Provide a summary description of the criticality code validation report, including: (1) a summary of the validated area of applicability and (2) the validation benchmark sets. Provide the validation report used to prepare the criticality analysis for the facility. The guidance in NUREG-1520, Section 5.4.3.1.7.1, states that the applicant should include a summary description of a documented, reviewed, and approved (by the applicant's nuclear criticality safety (NCS) function and management) validation report for each methodology that will be used to perform an NCS analysis, which should include, among others, those elements listed above. The information is necessary to determine whether the methodology is sufficiently rigorous and being applied in a manner consistent with its assumptions.

Description of Issue:

Section 5.5.3, "Computer Codes and Associated Safety Limits," discusses NCS codes used to calculate system reactivity. However, the applicant did not provide sufficient information on the calculation methods used to ensure an adequate margin of subcriticality for safety.

Regulatory Basis:

Consistent with the requirements in 10 CFR 70.65(b)(4), the ISA Summary must contain sufficient information on criticality monitoring to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61. Validation of calculation methods

is a vital part of ensuring an adequate margin of sub-criticality for safety as required in 10 CFR 70.61(d).

3.2 Observation – (Criticality)

Additional Information Needed:

For each process or equipment component that has special nuclear material associated with it, identify the amount, type, and location of fissionable material that will be present.

Description of Issue:

The locations and descriptions of special nuclear material to be used in the facility are needed to assess criticality hazards.

Regulatory Basis:

10 CFR 70.62(a) requires the establishment and maintenance of a safety program to demonstrate compliance with the performance requirements of 10 CFR 70.61.

3.3 Observation – (Criticality)

Additional Information Needed:

In Section 5.5.2, Methods of Control, under bullet 11, Reflection, clarify that there will be no special reflectors (i.e., reflectors that are more effective than water), other than those identified within the subsections of this bullet.

Description of Issue:

Concrete, carbon, and polyethylene are called out as being considered in the NCS analyses that will be performed, however additional clarity is needed on the potential presence or absence of other very efficient reflector materials, like beryllium, etc., at the facility, which could adversely affect the bounding criticality safety analyses for the fuel fabrication facility.

Regulatory Basis:

This information is needed to confirm compliance with 10 CFR 70.22(a)(8) and 70.24(a).

4 CHEMICAL SAFETY

4.1 RSI – (Chemical)

Supplemental Information Needed:

The license application (LA) needs to discuss how the TRISO-X ISA will identify, analyze and mitigate as appropriate credible chemical accident sequences that are under NRC's regulatory jurisdiction including those involving non-inhalation exposure pathways. Historical examples at fuel cycle facilities include sprays and spills near workers and spill cleanup operations. The information is required to evaluate compliance with the requirements of 70.61 and 70.62.

Description of Issue:

The application does not describe how the ISA addresses accidents not involving inhalation exposure.

Section 6.2.4 of the LA discusses chemical exposure standards for chemical hazards that are under NRC regulatory jurisdiction. The discussion only addresses standards

applicable to the inhalation pathway. There also needs to be a discussion of the potential for or the sources of a standard for non-inhalation pathways (e.g., GHS hazards statements in chemical safety databases, NIOSH Skin Notation Profiles).

Section 5.8.2 of the ISA Summary states “Chemicals that are not listed in the Protective Action Criteria (PAC) database (<https://edms.energy.gov/pac>) and are not identified as an inhalation hazard by a Safety Data Sheet (SDS) are considered to have a low consequence in the event of a release and do not require further evaluation.”

The staff notes that the PAC database is for inhalation exposure. The above statement in the ISA Summary implies that the applicant will not evaluate accident sequences that do not involve inhalation (e.g., will not evaluate liquid acid spills that could result in dermal exposure).

Section 5.8.3 of the ISA Summary states that the chemical safety program implements an industrial hygiene safety program that includes several barriers to protect the worker and prevent/limit dermal and ocular exposure(s) but there is insufficient discussion of this program in the LA or the ISA Summary for chemical hazards that are under NRC’s regulatory jurisdiction.

The staff notes that some of the chemicals being used by TRISO-X (e.g., NaOH) have hazard statements that point to dermal exposure hazards. Also, there are NIOSH skin notation profiles for some of the TRISO-X chemicals (e.g., formaldehyde, sodium hydroxide).

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(3) and (4), the ISA Summary must include a description of the hazards and types of accidents identified in the ISA and include information that demonstrates compliance with the 10 CFR 70.61 performance requirements (e.g., including the requirements for acute chemical exposure). The exposure requirements are expressed in terms of physiological effects (e.g., endanger the life of worker, lead to irreversible or other serious, long-lasting health effect). There needs to be clarifying language that limits the exposure pathway (e.g., only inhalation). Note: The NRC staff issued guidance in Information Notice 2007-22 “Recent Hydrogen Fluoride Exposures at Fuel Cycle Facilities” (ML071410230) which provides additional information on the routes of exposures that could lead to intermediate and high consequence events.

4.2 RSI – (Chemical - Facility and Process Description)

Supplemental Information Needed:

More information is needed about the facility and the processes including equipment sizes, process inventories (particularly chemicals that could produce high consequence accidents), sensors/controls, supporting systems (particularly ventilation) that will influence the transport of released or generated hazardous materials. While the need is general (i.e., across all processes)[REDACTED]

More information is required for the ISA Summary particularly for those processes or operations where the potential for high consequence events has been identified in the applicant’s ISA Summary.

Description of Issue:

The description of the facility and processes in the LA and ISA Summary need additional information to support staff review and evaluation of the safety analysis, particularly those areas where the ISA Summary has identified the potential for high consequence events.

Regulatory Basis:

This information is necessary to assess compliance with 10 CFR 70.65(b)(2) and (3), which requires the application to include information describing the facility with emphasis on those areas that could affect safety and a description of each process in sufficient detail to understand the theory of operation.

4.3 RSI – (Chemical - Hazard Information)

Supplemental Information Needed:

[REDACTED] The ISA Summary should discuss the nature of these chemical hazards which can provide high consequence events in the TRISO X operations and any facility conditions that would lead to the development of such hazards.

Description of Issue:

[REDACTED]

Regulatory Basis:

This information is necessary to support assessment of compliance with 10 CFR 70.65(b)(3), which requires that the application include information on the hazards (including chemical hazards).

4.4 RSI – (Chemical - Hazard Sequence Identification)

Supplemental Information Needed:

More information is needed on chemical hazard sequences (e.g., reactive hazards, toxic hazards). Section 4.2 of ISA Summary states that sequences were identified but additional discussion or summary is needed on the sequences in the ISA Summary. Accident sequences identified in Table 4-3.24 are more often a brief description of an event that is the result of an accident sequence rather than the accident sequence(s).

More information on the details of accident sequences is required for the ISA Summary, particularly for accident sequences that can result in high consequences.

Description of Issue:

The existing ISA summary needs additional discussion regarding the details of chemical accident sequences involving either toxic or reactive materials.

Regulatory Basis:

10 CFR 70.65(b)(3) requires the application to include information on the accident sequences (including chemical hazard sequences).

4.5 RSI – (Chemical - Consequence Assessment)

Supplemental Information Needed:

More information is needed on chemical consequence calculation including how information from the specific accident sequence (process and facility parameters) are

used in the consequences calculation, particularly calculations for accident sequences that result in high chemical consequences.

The ISA summary discusses the results of chemical safety consequence analysis in Section 4.2.3. Some of these calculations are bounding ones that are used to determine quantities that will result in high or intermediate consequences. No details of the analyses are presented, some of which are for sequences that involve chemical releases in fires.

More information on the basis for determining chemical accident consequences is required in the ISA Summary to allow the staff to assess the consistency between the facility characteristics, the accident sequence, and the assumptions used in the consequence assessment.

Description of Issue:

The existing ISA summary needs additional discussion regarding chemical accident sequences, consequence assessment, or the basis for consequence classification, particularly for sequences that involve intermediate or high consequences. The more detailed information is necessary to allow the staff to assess the consistency between process and facility characteristics (e.g., inventories, room volumes), the details of the accident sequence and the parameters used in the consequence assessments.

Regulatory Basis:

In order to comply with 10 CFR 70.65(b)(4), the application must discuss compliance with the requirements of 70.61 which requires classification of chemical accident consequences involving acute chemical exposure.

4.6 RSI – (Chemical - IROFS)

Supplemental Information Needed:

More information is needed on the specifics of IROFS to allow the staff to more clearly understand the role of the IROFS in meeting the performance requirements of 70.61, particularly those related to chemical safety.

Description of Issue:

Some of the IROFS descriptions state that the IROFS are necessary to assure that chemical concentrations do not exceed chemical threshold limits. This description needs to include an identification of the specific chemicals or specific limits and whether the IROFS is necessary to prevent intermediate or high consequences. (e.g., CHRA-1 and 2). Also, some IROFS appear to present design options for the final design (e.g., CHRA-1, CHRA-10, CHRA-29, CHRA-42) but do not identify which if any of the options are implemented.

Regulatory Basis:

10 CFR 70.65(b)(6) requires the application to describe items relied on for safety.

4.7 Observation – (Chemical)

Additional Information Needed:

Additional information is needed on the following topics: 1) information about the process, equipment, facility, etc. which is needed to allow the reviewer to gain insights

into potential accidents, (2) information on specific accident sequences identified by the Integrated Safety Analysis (ISA), and (3) information on the specific, quantitative results of any chemical accident consequence analysis.

Description of Issue:

These Observations are not necessary to support the acceptance review but are needed updates in the ISA Summary to enable understanding of the hazard identification and analysis conducted in the ISA.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(3) and (4), the ISA Summary must include a description of the hazards and types of accidents identified in the ISA and include information that demonstrates compliance with the 10 CFR 70.61 performance requirements

5 FIRE SAFETY

5.1 RSI – (Fire)

Supplemental Information Needed:

Provide the following information in the license application:

- A. types of construction, materials, insulation, weight support, and thickness for the buildings and rooms (e.g., wall, ceiling, floor, door, window)
- B. ventilation system and exhaust air and particulate systems (number, locations, and discharge rates of air and effluent outlet ducts)
- C. temperature detector, fire and smoke detector, and fire alarm system
- D. spacer, barriers, walls, windows, or other means to contain fire within the area
- E. electric systems in accordance with National Fire Protection Association (NFPA) 70 (National Electrical Code)
- F. hour ratings of wall, floor, ceiling, doors, and windows per International Building Code, and
- G. fire suppression systems (e.g., sprinklers, extinguishers, fire dampers, hydrants, and standpipe and hose systems)

In addition to the above items, provide the building layouts that show the locations of these fire safety features listed above for justification that the safety features are installed appropriately.

Description of Issue:

Section 7.4 of the LA Chapters 1-13 (Enclosure 2) describes the facility design of the TRISO-X fuel fabrication facility. The application needs to detail the fire safety features of the main process building (i.e., Nuclear Manufacturing Building) in Chapter 7, in accordance with NFPA 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials," and Section 7.4.3.3 of NUREG 1520 Rev.2:

Regulatory Basis:

In accordance with 10 CFR 70.22(a)(7), the application must include a "description of equipment and facilities which will be used by the applicant to protect health and minimize danger to life or property." The guidance in NUREG-1520, Revision 2, includes

the acceptance criteria in Section 7.4.3.3, “Facility Design,” which provides an acceptable approach for demonstrating compliance with the regulations.

5.2 RSI – (Fire)

Supplemental Information Needed:

- A. Provide the timeline and process for the NRC staff to access the Fire Protection Program (FPP) and the Fire Hazard Analysis (FHA) for the NRC staff’s review (e.g., online) for understanding/evaluation of the fire protection measures and systems at TRISO-X.
- B. Provide a table to summarize the key parameters (e.g., process operations, room area size, material construction, etc.) and their values used in the FHA. Provide the likely locations for the fire to occur in the main process building (Nuclear Manufacturing Building).
- C. Make the pre-fire plan for the main process building (Nuclear Manufacturing Building) available for staff’s review (e.g., online) for understanding and evaluation.
- D. Describe key information of the pre-fire plan for the main process building (i.e., Nuclear Manufacturing Building). The pre-fire plan should include information needed by fire-fighting personnel responding to the emergency.

Description of Issue:

Chapter 7 of the LA Chapters 1-13 (Enclosure 2) states that there is a FPP designed to provide reasonable protection against fire and explosive hazards, an FHA and pre-fire plans prepared for each building.

Regulatory Basis:

In accordance with 10 CFR 70.22, “Contents of applications,” the application must provide sufficient description of equipment, facilities and proposed procedures used to protect health and minimize danger to life or property. In addition, in accordance with 10 CFR 70.65(b)(6), the application must describe each IROFS in, “sufficient detail to understand their functions in relation to the performance requirements.” The guidance in NUREG-1520, Revision 2, includes the acceptance criteria in Sections 7.4.3.1, “Fire Safety Management Measures” and 7.4.3.2, “Fire Hazard Analysis,” which provide an acceptable approach for demonstrating compliance with the regulations.

5.3 RSI – (Fire)

Supplemental Information Needed:

The application needs to clearly specify the applicable passive engineering controls (PECs), active engineering controls (AECs), and administrative controls (ACs) under each of the fire hazard descriptions (types) listed in each of the tables located in Section 3 of ISA Summary (Enclosure 7).

Description of Issue:

Section 3 of ISA Summary (Enclosure 7) provides tables for fire hazard summary for all operations of the new TRISO-X fuel fabrication facility application (see Tables 3-1.4, 3-2.4, 3-3.4, 3-4.4, 3-5.4, 3-6.4, 3-7.4, 3-8.4, 3-9.4, 3-10.4, 3-12.4, 3-13.4, 3-13.8, 3-14.4, 3-16.1, 3-17.4 and 3-18.4). Each table contains information on fire hazard description (type), PECs, AECs, and ACs. It’s not clear whether all PECs, AECs and ACs listed in a table are applied to all fire hazard types/descriptions or just some of the fire hazard types/descriptions listed in that table.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(3), the ISA Summary must include a description of each process analyzed in the ISA in sufficient detail to understand the theory of operation, and for each process, the hazards that were identified in the ISA, and a general description of the types of accident sequences. The guidance in NUREG-1520, Revision 2, includes the acceptance criteria in Sections 7.4.3.4, "Process Fire Safety," which provides an acceptable approach for demonstrating compliance with the regulations.

5.4 RSI – (Fire)

Supplemental Information Needed:

Specify editions of the NFPA Codes in the license application and the ISA Summary for the items listed below:

- NFPA 10, Standard for Portable Fire Extinguishers
- NFPA 13, Standard for the Installation of Sprinkler Systems
- NFPA 14, Standard for the Installation of Standpipe and Hose Systems
- NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances
- NFPA 70, National Electrical Code
- NFPA 72, National Fire Alarm and Signaling Code
- NFPA 80, Standard for Fire Doors and Other Opening Protectives
- NFPA 86, Standard for Ovens and Furnaces
- NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems
- NFPA 101, Life Safety Code
- NFPA 220, Standard on Types of Building Construction
- NFPA 400, Hazardous Materials Code
- NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
- NFPA 499, Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
- NFPA 780, Standard for the Installation of Lightning Protection Systems
- NFPA 801, Standard for Fire Protection for Facilities Handling Radioactive Materials
- NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems

Description of Issue:

The license application and ISA Summary need to specify the applicable edition on each of the NFPA codes which are cited in the ISA Summary (Enclosure 7) for compliance with the updated fire protection standards. The edition is often based on the year of construction.

Regulatory Basis:

In accordance with 10 CFR 70.22(8), "Contents of applications," the application must provide sufficient description of proposed procedures used to protect health and minimize danger to life or property. Also, in accordance with 10 CFR 70.65(b)(2), the ISA

Summary must provide a “general description of the facility with emphasis on those areas that could affect safety.” The guidance in NUREG-1520, Revision 2, includes the acceptance criteria in Section 7.4.3.2, “Fire Hazard Analysis,” which provides an acceptable approach for demonstrating compliance with the regulations.

5.5 Observation – (Fire)

Additional Information Needed:

Please clearly identify in the ISA Summary Table 4-3.24 and Table 6-1.24 the safety disciplines applicable to each of the accident sequences (radiological, chemical and fire) or provide specific tables for each of the disciplines. This will provide the NRC staff with the applicant’s identified issues so they will be able to perform the appropriate evaluations on each of radiological, chemical, and fire safety disciplines.

Description of Issue:

ISA Summary Table 4-3.24 and Table 6-1.24 present the Radiological, Chemical Safety, and Fire Risk Index Assignments and the IROFS for Radiological, Chemical, and Fire, respectively, without specifying Risk Index Assignments and IROFS that are applicable to fire safety.

Regulatory Basis:

In accordance with 10 CFR 70.65(b)(6), the ISA Summary must describe each IROFS in, “sufficient detail to understand their functions in relation to the performance requirements.” The guidance in NUREG-1520, Revision 2, includes the acceptance criteria in Sections 7.4.3.4, “Process Fire Safety,” which provides an acceptable approach for demonstrating compliance with the regulations.

6 STRUCTURAL DESIGN

6.1 RSI – (Structural 1)

Supplemental Information Needed:

Provide the information necessary to demonstrate that the design criteria established for the structure provides for adequate protection against the natural phenomena hazards (NPH) that are applicable to the site and to demonstrate how the established design criteria considers the most severe documented historical events for the site.

Please provide the following information to support the application:

- (1) design-basis values for each of the meteorological (e.g., maximum snow and ice loads, maximum precipitation loads, tornado wind/missiles load, etc.), seismic (e.g., design-basis earthquake magnitudes and return periods), hydrological, and/or geological (e.g., potential settlement) design-basis events applicable for the design of the facility based on requirements and site-specific parameters, as defined by ASCE 7-16 and the International Building Code;
- (2) how the design-basis values for each credible NPH compares to and is found adequate when considering the most severe documented historical events for the site; and

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- (3) since Section 1.1.2 of Enclosure 2 of the application only addresses the design for a seismic event, how other NPH (e.g., high winds, tornado, local intense precipitation, etc.) were considered in the design of the facility so that structures can be found to provide adequate protection against the NHP.

Description of Issue:

The application needs sufficient information (i.e., a summary of design-basis values) to demonstrate how the proposed new facility is designed to provide for adequate protection against each credible NPH and to demonstrate how the established design criteria considers the most severe documented historical events for the site, in accordance with 10 CFR 70.64(a)(2). Specifically, Section 1.1.2 of Enclosure 2 of the application states that the structures and facilities will be designed to the building code of record (i.e., 2018 Edition of the International Building Code) with seismic loadings based of the 2018 Edition of the International Building Code and American Society of Civil Engineers (ASCE) 7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structure." However, the application does not include a summary of the design-basis values considered in the structural analysis for all the design-basis events (e.g., meteorological, seismic, hydrological and/or geological events for the site) that are applicable to the design of the facility.

Regulatory Basis:

This information is necessary to demonstrate compliance with the requirements of 10 CFR 70.64, in accordance with 10 CFR 70.65(b)(4). The guidance in NUREG-1520, Revision 2, includes the acceptance criteria in Sections 1.3.3 and 1.3.4, which provide a general description of some of the information necessary to demonstrate compliance with the regulations.

6.2 RSI – (Structural 3.1)

Supplemental Information Needed:

For the structure(s) credited to mitigate the consequences associated with NPH for the site, provide the information necessary to demonstrate compliance with the performance requirements of the item(s) relied upon to mitigate the potential consequences and to demonstrate that it will be available and reliable to perform its intended function when needed.

Description of Issue:

Section 4.2.5.2 of the ISA states that the design-basis high wind, tornado, and flooding events will not impact internal process equipment because the building is designed to withstand these events. However, it is not clear why the ISA does not designate the building as an IROFS when the structure is being credited as the item relied upon to mitigate the potential consequences of these events and is, therefore, necessary to limit the risk of these events affecting the internal process equipment. As stated in 10 CFR 70.61(b), each engineered or administrative control or control system necessary to comply with 10 CFR 70.61 shall be designated as an IROFS.

Regulatory Basis:

This information is necessary to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61, and the required criteria of 10 CFR 70.64(a)(2) to demonstrate that the design provides for adequate protection

against natural phenomena with consideration of the most severe documented historical events for the site.

6.3 RSI – (Structural 3.2)

Supplemental Information Needed:

Provide the information necessary to demonstrate compliance with the performance requirements of the item(s) relied upon to mitigate the potential consequences of a flood-induced hazard during a local intense precipitation event, and for the design criteria of structural elements or systems credited to mitigate the risk associated with the occurrence of this event.

Description of Issue:

Section 4.2.5.5 of the ISA states that administrative actions will be taken during a local intense precipitation event (heavy rain) to secure process equipment, seal containers of special nuclear materials and/or relocate the containers to other areas of the facility due to the expected increased runoff from adjacent higher elevation properties to lower areas of the site. However, the ISA does not further evaluate this hazard, its consequence, and actions, and does not capture the proposed mitigative actions as an IROFS, as they are intended to reduce the consequence from a credible flood-induced event due to local intense precipitation. The analysis should also consider what other structural elements or systems are credited to mitigate the potential consequences of this event like the effects of cumulative rain load on structural systems (e.g., roof), if relied on for the protection of or to mitigate the consequences to internal process equipment. As stated in 10 CFR 70.61(b), each engineered or administrative control or control system necessary to comply with 10 CFR 70.61 shall be designated as an IROFS.

Regulatory Basis:

This information is necessary to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61, and the required criteria of 10 CFR 70.64(a)(2) to demonstrate that the design provides for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site.

6.4 RSI – (Structural 3.3)

Supplemental Information Needed:

Provide the information necessary to demonstrate how the potential consequences of a maximum snow or ice hazards from a storm event was considered and for the design criteria of any structural systems credited to reduce the likelihood of occurrence of this event.

Description of Issue:

Section 1.3 of the ISA describes the average annual snowfall for the site and further describe severe storm conditions as infrequent. However, the ISA does not further evaluate this hazard, its consequence, or provide for the design against this NPH. The analysis should also consider what other structural systems are credited to mitigate the potential consequences of this event due to cumulative snow and/or ice loads effects on structural systems (e.g., roof) if relied on for protection. As stated in 10 CFR 70.61(b), each engineered or administrative control or control system necessary to comply with 10 CFR 70.61 shall be designated as an IROFS.

Regulatory Basis:

This information is necessary to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61, and the required criteria of 10 CFR 70.64(a)(2) to demonstrate that the design provides for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site.

6.5 RSI – (Structural 3.4)

Supplemental Information Needed:

Include the information necessary to demonstrate how higher intensity tornado hazards were considered for the design of the facility for NPH based on the most severe documented historical events for the site.

Description of Issue:

Section 1.1.1.2 of the enclosure 2 of the application states, in part, that Eastern Tennessee experiences tornado outbreaks of varying magnitudes approximately every 3 to 6 years, where the highest intensity tornadoes were rated F3 as a result of storms on February 21, 1993. Section 4.2.5.4 of the ISA states that the building is capable of withstanding wind speeds up to 110 miles per hour associated with an EF1 tornado on the Enhanced Fujita scale, which has a calculated probability of 2×10^{-4} per year. However, the application does not provide sufficient information to demonstrate how the effects of tornadoes with higher intensity (i.e., up to F3 intensity) were considered for the site based on the most severe documented historical events.

Regulatory Basis:

This information is necessary to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61, and the required criteria of 10 CFR 70.64(a)(2) to demonstrate that the design provides for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site.

6.6 RSI – (Structural 3.5)

Supplemental Information Needed:

Address the impact of the newly proposed Oak Ridge airport that will be located in close proximity of the TRISO-X Site.

Description of Issue:

Section 1.1.1.2 of the enclosure 7 of the application seeks to address the impact of local and regional airports to the facility and its design. The application considered the McGhee Tyson Airport, as the main airport, and other local airports that are operated in the Knoxville region. However, the newly proposed Oak Ridge airport that is planned to be built near the site, and it is not clear how this airport and flight patterns were considered or evaluated for the TRISO-X site. Information about the new airport can be found in the City of Oak Ridge website

(<http://www.oakridgetn.gov/content.aspx?article=5203>)

Regulatory Basis:

This information is necessary to demonstrate the licensee's compliance with the performance requirements of 10 CFR 70.61, and the required criteria of 10 CFR

70.62(c)(1)(i)-(iii) for identifying potential accident consequences caused by credible external events.

7 GEOTECHNICAL INFORMATION

7.1 RSI – (Geotechnical)

Supplemental Information Needed:

Describe the site topography and variation of surface elevation within the proposed site to show that a potential for slope stability problem does not exist.

Description of Issue:

The proposed TRISO-X site is located within the Valley and Ridge Province, as stated in LA Section 1.1.1.4, Geology and ISA Summary Section 1.5.1, Geology. The physiography consists of a series of northwest-southwest trending synclines and anticlines. The license application needs to describe the topography of the proposed site. LA Section 1.1.1.4, Geology, states that several shallow draws and depressions exist at the proposed site. If the surface elevation across the proposed site varies significantly, there may be a potential for slope stability problems.

Regulatory Basis:

This information is necessary to satisfy 10 CFR 70.22 and 70.65(b)(1).

7.2 RSI – (Geotechnical)

Supplemental Information Needed:

Demonstrate that the potential for a liquefaction of the soil layer(s) at the proposed site using the information from the site-specific geotechnical investigation conducted would not be significant.

Description of Issue:

The license application needs to provide information regarding engineering properties of the soil layer(s) at the proposed site to assess the liquefaction potential. LA Section 1.1.1.3, Hydrology, states that the groundwater table, as observed in four observation borings at the proposed site, is approximately 10 to 57 ft below the top of well casing. As stated in LA Section 1.1.1.4, Geology, the bedrock, comprised of dolomite and limestone, is overlain by soil layer(s) having thickness varying from 3.6 ft to 50 ft. Consequently, potential may exist that the soil layer(s) at the proposed site may liquefy under seismic loads.

Regulatory Basis:

This information is necessary to satisfy 10 CFR 70.22, 70.64(a)(2), and 70.65(a)(1).

7.3 RSI – (Geotechnical)

Supplemental Information Needed:

Demonstrate that potential differential settlement of the foundation of the proposed facility would not affect the safe operation of the proposed facility.

Description of Issue:

Section 1.1.1.4, Geology, and ISA Summary Section 1.5.1, Geology, state that the thickness of the soil layer(s) above the bedrock, measured during the geotechnical

drilling program conducted to support the facility design, varies from a minimum 3.6 ft to a maximum 50 ft. The license application should identify the locations within the site where these measurements have been observed. These measurements show that the proposed facility can experience significant differential settlement from both the immediate settlement and the long-term consolidation settlement because of significant difference in soil thickness.

Regulatory Basis:

This information is necessary to satisfy the requirements of 10 CFR 70.64(a)(2) and 70.65(a)(1).

7.4 RSI – (Geotechnical)

Supplemental Information Needed:

Demonstrate that the subsurface material(s) below the foundation has enough bearing capacity to avoid failure after construction of the proposed facility.

Description of Issue:

The license application should provide information to show that the subsurface material(s) below the facility foundation have enough capacity to sustain the additional loads imposed from construction of the proposed facility. In addition, as the thickness of soil layer(s) varies significantly within the proposed site, the presence of two materials with vastly different stiffness properties below the foundation may be a possibility resulting in spatially varying bearing capacity.

Regulatory Basis:

This information is necessary to satisfy the requirements of 10 CFR 70.64(a)(2) and 70.65(a)(1).

7.5 RSI – (Geotechnical)

Supplemental Information Needed:

Discuss the karst features observed in the dolomite and limestone bedrock during the geotechnical drilling program to support facility design with respect to the footprint of proposed facility, as illustrated in LA Figure 1-2, Site Plan.

Description of Issue:

As stated in LA Section 1.1.1.4, Geology, the carbonate rocks at and surrounding the proposed site “are subject to dissolution that may produce a range of features that include solution, collapse, cover-collapse sinkholes and caves. Based on the topography of the site, several shallow draws and depressions exist which may reveal karst features beneath the surface. Voids within the dolomite and limestone bedrock were encountered on the site during the geotechnical drilling program to support facility design.” The current submittal needs a discussion on how the observed karst features within the proposed site have been accounted for in determining the bearing capacity and settlement of the proposed facility and liquefaction at the proposed site.

Regulatory Basis:

This information is necessary to satisfy the requirements of 10 CFR 70.64(a)(2) and 70.65(a)(1).

7.6 RSI – (Geotechnical)

Provide information on engineering characteristics of the soil layer(s) and rock layers (e.g., dolomite and limestone) taken as bedrock. In addition, provide a geological cross-section of the site, developed based on the site geotechnical investigation. The plot should identify all the soil and rock layers encountered at the site. Additionally, the plot should also show the location of the proposed facility with respect to these geological units.

Description of Issue:

As stated in LA Section 1.1.1.4, Geology, and ISA Summary Section 1.5.1, Geology, the thickness of the soil layer(s) above the rock layers varies from 3.6 ft to 50 ft; however, it is not clear the locations within the proposed site where these measurements have been taken with respect to the footprint of the proposed facility. In addition, the application should include information on the engineering characteristics of the soil and rock layers presented.

Regulatory Basis:

This information is necessary to satisfy 10 CFR 70.22, 70.64(a)(2), and 70.65(a)(1).

8 ELECTRICAL AND INSTRUMENTATION AND CONTROL

8.1 RSI – (Electrical, Instrumentation and Control)

Supplemental Information Needed:

Update the ISA Summary and other documents, as needed, with the following information:

- **RSI**
 - Basis of design of IROFS, including description of how IROFS will be designed and failure modes considered for meeting the facility performance requirements under all postulated hazards and facility conditions
 - Identification of the design basis for IROFS, and list of industry codes, standards, and practices that will be applied in the design, implementation, and maintenance of the facility and its IROFS
 - Description of the facility power supply system, including off-site feeds, power distribution system, and electrical protection scheme within the facility for both normal and emergency power
 - Design basis and identification of industry codes, standards, and practices that will be applied in the design of the facility normal and emergency power supply systems
 - Design basis of instrument air supply system, if needed to support operation of IROFS
- **Observations:** These Observations are not necessary to support the acceptance review but will support the staff's technical review or provide a timeline and process for the NRC staff to access the information below (for planning purposes):
 - IROFS boundary documents

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- P&IDs, logic diagrams, and schematics associated with the proposed facility IROFS
- Calculations associated with process safety setpoints for required operation of IROFS to achieve safety performance
- Internal facility power normal supply distribution single line and protection scheme
- Facility emergency power supply distribution single line and protection scheme
- List of applicable codes and standards associated with the normal and emergency power supply systems
- Instrument air requirements, if needed for ensuring the reliability and availability of IROFS

Description of Issue:

The staff's technical reviewers for electrical and instrumentation and controls evaluated the license application, ISA Summary, and related enclosures as part of its acceptance review. The staff finds that the ISA Summary identifies the names of facility proposed IROFS but does not contain sufficient information to enable the staff to understand how the applicant plans to implement the baseline design criteria nor sufficient information to enable the staff to begin its evaluation as to whether the proposed facility design demonstrates that the baseline design criteria identified in the regulations will be adequately addressed. Also, the staff finds that the ISA Summary needs additional information to enable a determination as to whether the proposed management measures associated with the electrical and I&C systems design and operation of IROFS will ensure the IROFS will be available and reliable to enable them to perform their required safety actions when needed. Further, the ISA Summary needs additional information that enables the staff to verify that the concept of defense in depth has been applied to the design of the facility and its IROFS.

Regulatory Basis:

The information is needed to demonstrate compliance with the performance requirements in 10 CFR 70.61, to address the baseline design criteria of 10 CFR 70.64. Also, the information is needed for the staff to verify compliance of the proposed facility design to 10 CFR 70.62(d) regarding the adequacy of management measures applied to ensure that engineered and administrative controls and control systems that are identified as items relied on for safety pursuant to 10 CFR 70.61(e) are designed, implemented, and maintained, as necessary, to ensure they are available and reliable to perform their function when needed, to comply with the performance requirements of 10 CFR 70.61.

9 HUMAN FACTORS

9.1 RSI – (Human Factors)

Supplemental Information Needed:

The TRISO-X license application was reviewed with respect to programmatic (organizational) aspects and specific technical details regarding Human Factors Engineering (HFE) in the ISA summary. The review focused on the administrative controls that would involve human actions as they are related to IROFS and the approach used to identify and address safety features in the facility which require a human factors evaluation. The application did reference the use of HFE in the safety analysis approach in supporting IROFS.

Human Factors need to be considered for administrative and enhanced administrative IROFS. The application of Human Factors Engineering to personnel activities ensures that the potential for human error in the facility operations is addressed during the design of the facility. A graded approach commensurate with the complexity of the administrative components of IROFS is used to demonstrate compliance with 10 CFR 70.61(e).

Please provide the following information to demonstrate that HFE has been incorporated appropriately into the ISA and throughout the facility.

1. Identify the personnel activities of the administrative controls significant to safety, as determined in the ISA.
2. Describe the administrative controls included in IROFS which have safety significance.
3. Describe the human systems interfaces (HSIs) involved with the administrative controls included in the IROFS, and the potential consequences associated with these personnel activities.
4. Describe the approach and specify the technical standard used as a basis for the HFE design review of the facility safety systems. Specifically, describe how HFE practices and guidelines will be implemented during the design, construction, and operation of the facility.
5. Design facilities, systems, equipment, and tools so they are sensitive to the capabilities, limitations, and needs of humans.
6. Ensure that an operator can perform the items required in the timeframes assumed in the safety analysis.
7. Ensure administrative IROFS are clearly defined so personnel understand the limits and required actions.
8. Ensure IROFS provide acceptable limits that will not adversely impact other safety disciplines
9. Evaluate potential IROFS failures to ensure that common mode or common cause failures do not exist for accident sequences that involve more than one IROFS.
10. State that IROFS have been developed with the support of operations and process engineering personnel to appropriately identify the personnel required actions and human interfaces with active controls when enhanced administrative IROFS are developed.

In addition, provide a standard on which the human factors approach can be based. For example, consider providing a reference to an Institute of Electrical and Electronics Engineers standard or an NRC standard such as NUREG-0711, "Human Factors Engineering Program Review Model." This is important to evaluate the graded approach referenced by the applicant.

Description of Issue:

Title 10 of the Code of Federal Regulations (10 CFR) 70.61(e) requires a safety program to ensure that each IROFS will be available and reliable to perform its intended function when needed. Therefore, the applicant should identify those "personnel activities" that are considered IROFS and personnel activities that support safety (e.g., maintenance). Also, the applicant should demonstrate how personnel activities will enhance safety by reducing challenges to IROFS,

Regulatory Basis:

The information is needed to demonstrate compliance with 10 CFR 70.64(b)(2). The guidance in NUREG-1520, Revision 2, includes the acceptance criteria in Appendix E, "Human Factors Engineering For Personnel Activities" which provides an acceptable approach for demonstrating compliance with the regulations.

10 PRINCIPLE CONTRIBUTORS

The NRC staff reviewers involved in development of the RSIs are listed in the table below.

Contributors to the RSI Package

Review Discipline	Primary Reviewer
General Information	Matt Bartlett
Integrated Safety Analysis	Mike Call
Nuclear Criticality Safety	Jeremy Smith
Chemical Safety	James Hammelman
Fire Safety	Jimmy Chang
Structural Design	Juan Lopez
Geotechnical Information	Amit Ghosh
Electrical and Instrumentation and control	Ming Li and David Rahn
Human Factors	Martin Kamishan