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TX0-REG-LTR-0030

ELECTRONIC DELIVERY

December 20, 2023

Director, Office of Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

References:
1) Docket No. 70-7027
2) TRISO-X letter from Jennifer Wheeler to Director, Office of Nuclear Material Safety and Safeguards, "TRISO-X Fuel Fabrication Facility Environmental Report Submittal," dated September 23, 2022
3) NRC letter from Jill Caverly, Acting Chief, Environmental Project Management 2 Branch, to Jennifer Wheeler, Director, Regulatory Affairs "Request For Additional Information Part 2-1 For The Application From TRISO-X, LLC For Special Nuclear Material License For Use At A Fuel Fabrication Facility In Oak Ridge, Tennessee (Docket Number: 70-7027)" dated November 20, 2023

Subject: **Response to Request for Additional Information Part 2-1 for the TRISO-X Environmental Report and License Application**

TRISO-X, LLC (TRISO-X) hereby submits responses to the subject Request for Additional Information (RAI), regarding the review of the Environmental Report for the TRISO-X Fuel Fabrication Facility (Reference 2). The enclosed responses are for the RAI set transmitted by letter dated November 20, 2023 (Reference 3).

Requests for Withholding

None. The enclosed submittal contains public information.

Summary of this Submittal

The following Enclosures are included with this letter.

Enclosure 1 – RAI Part 2-1 Responses for the TRISO-X Environmental Report and License Application

If there are questions or if additional information is required, please contact me at (865) 850-0893 or jwheeler@triso-x.com.

Sincerely,

Jennifer Wheeler

Jennifer K. Wheeler, P.E.
Vice President, Regulatory Affairs

TRISO-X, LLC
801 Thompson Avenue
Rockville, MD 20852

Copy: Jill Caverly, US NRC
TRISO-X Regulatory Records File

Enclosure 1 - RAI Part 2-1 Responses for the TRISO-X Environmental Report and License Application

Introduction – Applicable Regulatory Requirements, Permits, and Required Consultations

RAI2-1 ER-INT-1

Provide an assessment of whether a Department of Energy (DOE) Excavation/Penetration Permit (EPP) would be required prior to initiating construction at the Horizon Center Site (HCS). Additionally, provide revised and updated versions of tables 1.4-1, "Permits and Approvals Required for Construction and Operation," and 1.4-2 "Consultations Required," including the status of the EPP permit application, should it be required.

During the public scoping process, the Tennessee Department of Environment and Conservation (TDEC) commented that coordination with the DOE's EPP program may be required for development of the HCS, since the EPP program is in place for many sites in the vicinity of the HCS as a land use control for excavations at a depth greater than two feet below ground surface. Revised and updated versions of tables 1.4-1 and 1.4-2 are necessary to provide the most up-to-date status of required permits and consultations in the draft EIS.

TRISO-X Response to RAI 2-1 ER-INT-1

TRISO-X reviewed *Amendment Number Three to Declaration of Covenants, Conditions and Restrictions of the Horizon Center*. The covenants do not mention or require the DOE Excavation/Penetration Permit. The nearby East Tennessee Technology Park does potentially require a DOE EPP. Review of DOE/EA-1640, *Transfer of Land and Facilities within the East Tennessee Technology Park and Surrounding Area, Oak Ridge, Tennessee*, (October 2011) indicates under *Geology and Soils*, page 6 of 126:

> "The Excavation/Penetration Permit Program is a DOE control for operations and ongoing cleanup activities. Deed restrictions could be included that require the property owner to obtain an excavation/penetration permit from DOE, as long as DOE's program is in place. The Zone 1 and Zone 2 Records of Decision have a current restriction on excavation below 10 ft without proper controls. Similar restrictions would be placed in Covenant Deferral Requests, as necessary."

Note that Figure 3.1, *Zone 1 and Zone 2 at ETTP*, of DOE/EA-1640 shows the two zones of interest are located in the East Tennessee Technology Park (southwest of the Horizon Center Site). The Horizon Center is not located within the ETTP and therefore is not shown on the figure.

The TRISO-X site is located within Parcel ED-1, as identified in the 1996 DOE/EA-1113, *Environmental Assessment, Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council,* and subsequent EA addendums. Specific to this property, a 1995 letter from the EPA to DOE states the following

> "…, the EPA concurs with DOE's identification of uncontaminated property within Parcel ED-1. Based on the 'Review of Parcel ED-1', EPA concurs with DOE's determination that there is no evidence of any storage, release or disposal of any hazardous materials or petroleum products on Parcel ED-1 outside of the floodplain sediments of East Fork Poplar Creek and Bear Creek."

This finding is further supported by a 2001 letter from EPA to DOE, which confirmed the "clean parcel" determination for parcel ED-1. Therefore, based on a review of the Horizon Center

covenants and restrictions, and the DOE "clean parcel" determination for Parcel ED-1, a DOE EPP is not required prior to initiating construction at the Horizon Center Site.

RAI2-1 ER-INT-2

Provide a detailed description of the pre-construction activities TRISO-X LLC (TRISO-X) has completed to-date at the HCS and any further pre-construction activities that TRISOX anticipates completing at the HCS in 2023 through 2024.

Up-to-date Information regarding TRISO-X's pre-construction activities at the HCS is required to accurately describe the current disposition of the HCS when describing the potential environmental impacts the project may have on the site.

TRISO-X Response to RAI 2-1 ER-INT-2

No pre-construction activities have been completed at the HCS as of December 2023 other than installation of 4 groundwater monitoring wells in 2021. Pre-construction activities planned to start in 2024 include civil site development work required to prepare the site for construction of the planned TRISO-X facilities. This phase of work consists of clearing and grubbing, excavation and rough grading to establish the site design elevations, construction of stormwater management features, ground improvement for future foundations, site roadway installation up to the base course (but not including pavement), installation of a perimeter security fence, construction of temporary gravel construction laydown areas, and providing temporary electric service and water service to be used during construction. Site grading will be performed in accordance with grading and drainage plans that have been reviewed and approved by the Tennessee Department of Environment and Conservation, and the City of Oak Ridge.

Proposed Action

RAI2-1 ER-PA-1

Provide a description of the existing utilities in the vicinity of the FFF site and what would be required to extend them to the site to provide service to the FFF including any potential impacts on the surrounding environment. Additionally, discuss whether hazards associated with natural gas explosions have been assessed for the FFF, including engineered and administrative controls to prevent or mitigate such natural gas hazards.

Section 2.1.2.1.1 of the ER, "Facility Description," TRISO-X discusses municipal water supply, sanitary sewer, natural gas, and overhead electrical transmission lines that would service the TRISO-X fuel fabrication facility (FFF) as though the FFF is already constructed, and the lines are already in place. The ER does not describe whether these lines are currently in place or would need to be constructed/extended to reach the FFF site. If new lines would be required, provide a discussion of the associated impacts on the existing environment that would occur as a result of the construction.

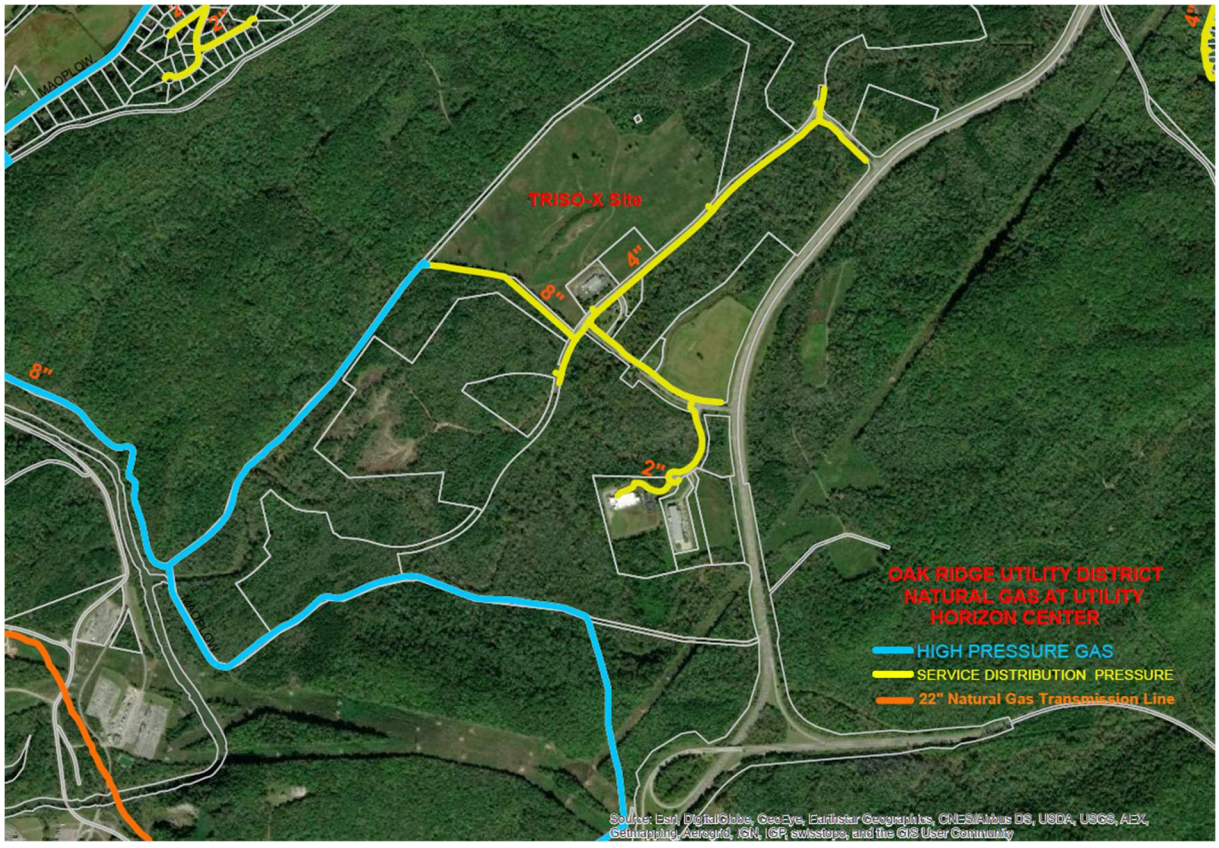
TRISO-X Response to RAI 2-1 ER-PA-1

Existing underground natural gas, potable and fire protection water, sanitary sewer, and telecommunication service lines are located within the utility easements along Renovare Boulevard. Connections for these utility services are made in the utility easements at locations agreed to with the utility providers. The underground utilities are then routed through the site to

the tie-in connections with the TRISO-X FFF buildings. Potential impacts on the surrounding environment from the underground utility construction are minimal.

A 22-inch natural gas transmission line (pipeline ID 3100-1, shown in orange in the figure below) operated by East Tennessee Natural Gas is located approximately 1.25 miles southwest from the nearest corner of the TRISO-X site. TRISO-X assessed hazards from this natural gas transmission line using ALOHA. The ALOHA results indicate that the overpressure from a vapor cloud explosion or the thermal radiation from a jet fire would not damage the TRISO-X facility. Therefore, no engineered or administrative controls are used to prevent or mitigate natural gas hazards.

Natural gas service to the local area is provided by Oak Ridge Utility District. The natural gas service line follows the western border and southern border (along Renovare Blvd) of the TRISO-X site. A natural gas regulator station is located at the northwest corner of the TRISO-X site (see the blue/yellow transition in the figure below). The line upstream of the regulator station is an 8-inch steel line operating at 150 psi (blue line in figure). The line downstream of the regulator station is an 8-inch HDPE line operating at 40 psi (part of yellow line in figure), which transitions to a 4-inch HDPE line at the southwest corner of the site. The 4-inch HDPE line follows Renovare Blvd. Based on these line sizes and pressures, the bounding natural gas service accident scenario is an explosion located upstream of the regulator station from the 8-inch steel line operating at 150 psi. TRISO-X assessed hazards associated with a natural gas explosion using ALOHA. The ALOHA results indicate that the overpressure from a vapor cloud explosion or the thermal radiation from a jet fire would not damage the TRISO-X facility. Therefore, no engineered or administrative controls are used to prevent or mitigate natural gas hazards.



Enclosure 1 - RAI Part 2-1 Responses for the TRISO-X Environmental Report and License Application

Alternatives

RAI2-1 ER-ALT-1

Provide a description of the rationales for the rankings of the five candidate alternative FFF site locations "based on the further evaluation results," as described in section 2.2.1 of the ER, and why the HCS was selected as the preferred alternative if the Centrus American Centrifuge Plant (ACP) site in Piketon, Ohio was ranked higher in the TRISO-X assessment.

A more detailed explanation of the alternative site assessment process is required to sufficiently describe the process in the EIS. In Section 2.2.1 of the ER, "Facility Location," TRISO-X discusses the site study performed to evaluate potentially suitable sites for the siting of the FFF. The ER notes that the five candidate sites that were selected based on the Electric Power and Research Institute (EPRI) Siting Guide were subsequently examined in more detail and ranked from highest to lowest based on further evaluation results. However, the ER does not specify what specific parameters of each site led to their respective placements in the 1 to 5 ranking or provide a rationale as to why the HCS was chosen as the preferred alternative if the Centrus ACP, site in Piketon, Ohio was ranked higher.

TRISO-X Response to RAI 2-1 ER-ALT-1

The goal of the site study was to recommend one or more suitable sites from an environmental, engineering and community acceptance standpoint, to be used by the owner in conjunction with the owner's economic evaluation, and other evaluations, to select a Proposed Site.

The five identified candidate sites were then examined in more detail to determine whether the candidate sites had any significant environmental, engineering, or nuclear licensing issues that would make them impractical or otherwise undesirable for development of the TRISO-X Facility. The purpose of this evaluation is to determine if any site is obviously superior from an environmental perspective as required by 10 CFR Part 51.

The five candidate sites were evaluated for 35 different site characteristics in 8 different categories. Each of the site characteristics have both "Must" and "Want" requirements. If a site did not meet the "Must" conditions, it was eliminated from further consideration. However, none of the 5 sites were eliminated for not meeting a "Must" requirement.

The criteria included an objective means of assigning a numerical score for each site characteristic and importance weighting factors, which were used to evaluate the sites based on the relative importance of the site characteristics. Each of the sites was given a score from 1 to 5 for the "Want" requirements for each of the 35 characteristics, and each of the 35 characteristics was weighted from 1 to 10 based on the relative importance for the project.

The site characteristics, Must and Want conditions, numerical scoring criteria, possible scores, and importance weighting factors were decided upon through internal discussions and were based regulatory requirements and best practices. They are consistent with the EPRI Siting Guide and with the methods used for other nuclear power facility siting studies.

Based on the detailed examination, the study determined that all five of the candidate sites were suitable for the TRISO-X Facility and that there were no obviously superior alternative sites. The study recommended moving forward with full site characterization for any one of the five sites listed above, after selection based on further economic and other evaluations.

Enclosure 1 - RAI Part 2-1 Responses for the TRISO-X Environmental Report and License Application

Section 2.2.1 of the Environmental Report will be revised to incorporate discussion of the site selection process.

Environmental Report Changes

Environmental Report, Chapter 2, Section 2.2.1 “Facility Location” will be revised per the redline text below.

2.2 ALTERNATIVES CONSIDERED BUT ELIMINATED

2.2.1 FACILITY LOCATION

A site study was performed to identify a site for the TRISO-X Fuel Fabrication Facility (TRISO X FFF) . The goal of the site study was to recommend one or more suitable sites for the siting of the TRISO-X FFF from a nuclear licensing, environmental, engineering, and community acceptance standpoint. The site study identified and screened potential sites in order to identify candidate sites for the TRISO-X FFF. Those candidate sites were further evaluated to determine if there is an obviously superior site ~~and ranked the candidate sites based on environmental, engineering, or nuclear licensing criteria~~ as defined by 10 CFR Part 51. The goal of the site study was to recommend one or more suitable sites from an environmental, engineering and community acceptance standpoint, to be used by the owner in conjunction with the owner’s economic evaluation, and other evaluations, to select a Proposed Site. The results of the site study are detailed further within this section.

The site study identified 25 potential sites or site areas in the U.S. for the siting of the TRISO-X FFF. Eleven of the potential sites are fuel cycle facilities licensed by the U.S. Nuclear Regulatory Commission (NRC). Four of the sites have been previously studied by the NRC for reactors but were never built and remain greenfield sites. Two of the potential sites are other nuclear sites or facilities. Four of the sites are industrial properties formerly owned by General Motors Corporation (GMC) that have been remediated for potential redevelopment. The GMC sites are now owned by an entity known as the RACER Trust and are available for redevelopment. Four of the sites are brownfield power plant sites. Two of the brownfield sites are retired fossil fuel electric generating units (EGUs) located in urban areas and were identified from lists published by the Energy Information Administration (EIA). Two of the brownfield sites are decommissioned nuclear plants for which the owners have announced the availability of the sites for disposition.

The potential sites were evaluated using a ranking methodology consistent with the Electric Power Research Institute (EPRI) Siting Guide (EPRI, 2002). The site selection criteria included the following environmental, technical, and social factors:

- The proximity to a source of high assay low enriched uranium (HALEU) in the form of U3O8 powder.
- Potential local government and community support for a proposed NRC-licensed facility.
- Access to a skilled nuclear workforce.
- Proximity to the interstate highway system.
- Available municipal water, sewer, and electric power infrastructure.
- Access to a well-developed health and safety infrastructure.

- Sufficiently large (at least 75 ac. [30.4 ha]) site generally free of potential environmental constraints (e.g., wetlands, floodplains, natural habitats for protected species, steep terrain and known cultural resources).
- Acceptable seismic characteristics.
- Proximity of karst formations.
- Frequency of inclement weather (e.g., tornadoes, hurricanes, and winter storms).
- Proximity of hazardous industrial facilities and potentially contaminated properties (e.g., oil refineries, pipelines, liquified natural gas facilities).
- Local and State environmental siting and permitting processes.
- Proximity to airports. This criterion identifies sites with access to commercial air travel but avoids sites near public or private-use airports that could pose additional hazards to the facility.

Using the ranking methodology, the following five candidate sites for additional evaluation were identified:

- Centrus American Centrifuge Plant (ACP), Piketon, Ohio.
- Centrus Technology Manufacturing Center (TMC), Oak Ridge, Tennessee.
- Horizon Center site (HCS), Oak Ridge, Tennessee.
- General Electric/Global Nuclear Fuel-A Facility (GE/GNF-A), Wilmington, North Carolina.
- Savannah River Site (SRS) Energy Park, Aiken, South Carolina.

The five identified candidate sites were then examined in more detail to determine whether the candidate sites had any significant environmental, engineering, or nuclear licensing issues that would make them impractical or otherwise undesirable for development of the TRISO-X Facility. The purpose of this evaluation is to determine if any site is obviously superior from an environmental perspective as required by 10 CFR Part 51.

The five candidate sites were evaluated for 35 different site characteristics in 8 different categories (NEW TABLE). Each of the site characteristics have both “Must” and “Want” requirements. If a site did not meet the “Must” conditions, it was eliminated from further consideration. However, none of the 5 sites were eliminated for not meeting a “Must” requirement.

The criteria included an objective means of assigning a numerical score for each site characteristic and importance weighting factors, which were used to evaluate the sites based on the relative importance of the site characteristics. Each of the sites was given a score from 1 to 5 for the “Want” requirements for each of the 35 characteristics, and each of the 35 characteristics was weighted from 1 to 10 based on the relative importance for the project.

The site characteristics, Must and Want conditions, numerical scoring criteria, possible scores, and importance weighting factors were decided upon through internal discussions and were based regulatory requirements and best practices. They are consistent with the EPRI Siting Guide (EPRI 2002) and with the methods used for other nuclear power facility siting studies.

Based on the detailed examination, the study determined that all five of the candidate sites were suitable for the TRISO-X Facility and that there were no obviously superior alternative sites. The study recommended moving forward with full site characterization

for any one of the five sites listed above, after selection based on further economic and other evaluations.

~~The five identified candidate sites were then examined in more detail to determine whether the candidate sites had any significant environmental, engineering, or nuclear licensing issues that would make them impractical or otherwise undesirable for development of the TRISO-X FFF. Based on the detailed examination, it was determined that all five of the candidate sites were suitable for the TRISO-X FFF and that there were no obviously superior alternative sites. The candidate sites were also ranked from highest to lowest as follows, based on the further evaluation results:~~

~~1. Centrus ACP, Piketon, Ohio~~
~~2. HCS, Oak Ridge Tennessee~~
~~3. Centrus TMC Site, Oak Ridge, Tennessee~~
~~4. GE/GNF-A Site, Wilmington, North Carolina~~
~~5. SRS Energy Park Site, Aiken, South Carolina~~

The HCS was selected over other evaluated sites because it provided the best opportunity to deploy the TRISO-X FFF, based on the criteria established in our site selection process. Specifically, the HCS was located in Oak Ridge, Tennessee, a community supportive of nuclear facilities, with close location to emergency resources such as fire and police. The site also offered no major environmental concerns, in terms of ground water quality, soil plasticity, karst, and archaeological artifacts. In addition, the Industrial Development Board of Oak Ridge offered the 110-acre (Lot 6a) site to TRISO-X at no cost and a 20-year payment in lieu of taxes program. In summary, the physical location of the site, properties of the site itself, and real estate offer made the HCS the best option for the commercial fuel facility.

New Table - Evaluation Criteria for Candidate Sites

No.	Description	Weight
A. Infrastructure and Utilities		
1.	Site Utilities	7
2.	Highway Access	3
3.	Existing Onsite Infrastructure	10
4.	Access to Emergency Healthcare	8
B. Site Development		
1.	Site Size and Topography	6
2.	Foundation, Earthwork and Pipe Installation Conditions	5
3.	Shallow Rock	3
4.	Groundwater Conditions	7
5.	Flood Protection	8
6.	Constructability	6
C. Seismic and Geotechnical Criteria		
1.	Proximity to Active and Inactive Faults	9
2.	Seismic Hazards	10
3.	Settlement and Liquefaction Potential	7
4.	Karst, sinkholes and subsidence	7
D. Site Security		
1.	Reserved	
2.	Reserved	
3.	Distance to Local Law Enforcement Agency (LLEA)	7
E. Land Use Issues		
1.	Existing Land Use on the Site	6
2.	Existing Land Use within 1 Mile of the Site	4

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No.	Description	Weight
3.	Zoning and Land Use Planning	8
4.	Parks and Recreation[1]	5
5.	Prime Farmland	5
F. Ecological Criteria		
1.	Wetlands, Lakes and Streams	8
2.	Other Natural Habitats	6
3.	Rare, Threatened and Endangered (RTE) Species	9
4.	Protected Natural Areas[2]	7
5.	Groundwater Impacts	8
G. Socioeconomic Criteria		
1.	Community Acceptance (with input from X-energy)	10
2.	Historic and Cultural Resources	4
3.	Aesthetic and Noise Impacts	6
4.	Environmental Justice	7
5.	Socioeconomic Impacts	5
H. Other Hazards		
1.	Aircraft Hazards	9
2.	Proximity to Hazardous Land Uses	7
3.	Proximity to Contaminated Properties	6
4.	Property Litigation	10
5.	Vehicle Controls	6

[1]These criteria apply to areas used primarily for human recreation, e.g. community parks, softball fields, swimming areas, etc.
[2]These criteria apply to areas used primarily for management of ecological resources. The areas may be public, institutional (e.g. universities) or private lands (e.g. Nature Conservancy) and may or may not be open to the public. The areas may allow and provide facilities for recreational use.

Land Use

RAI2-1 ER-LU-1

Provide a rationale for TRISO-X's use of a 5.38-mile radius land use study area and explain the land use resource area limits.

Section 3.1.2 of the ER, "Region," defines the region in which the FFF is located as the area within a 5.38-mile (8.66-kilometer) radius. However, the ER does not provide a rationale for choosing the specific 5.38-mile radius and nor does it describe the boundary of the land use resource.

This is required under 10 CFR 51.45. Staff developed this RAI with consideration of NUREG1748 Section 5.4.1. An applicant is encouraged, but not required to use the NUREG-1748 when preparing a response. The procedures in NUREG-1748 represent one method to demonstrate compliance with requirements established by legislation and regulations.

TRISO-X Response to RAI 2-1 ER-LU-1

A specific definition of the site vicinity or region is not included in either 10 CFR 51.45 or in NUREG-1748 Sections 5.3.1 Land Use; 6.3.1, Land Use; or 6.4.1 Land Use Impacts. NUREG-1748, Appendix F, Glossary, provides this definition: "vicinity -- The surrounding area of the proposed action. Depending on the action and environmental media being considered this can range from less than one mile to 50 miles."

Therefore, the ER relies primarily on professional judgement to define the "vicinity" for any particular section of the ER. For the land use resource, the vicinity is defined as the area within a 5.38-mile (8.66-kilometer) radius of the site center point. The 0.38-mile (0.61-kilometer) portion of the vicinity is a conservative bounding limit of the project site itself. The 5.00-mile (8.05-kilometer) portion of the vicinity is based on professional judgement as appropriate for the analysis of land use and land use impacts.

For reference, the 5.00-mile portion of the vicinity is consistent with Interim Staff Guidance Augmenting NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content," for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors, dated October 17, 2012. Section 19.2, Proposed Action, Site Location and Layout, requires the following information:

> "Site location, including distance and direction from the nearest major city, nearby towns, nearby inhabitants, sensitive populations (e.g., schools, daycare facilities, retirement homes, etc.), and landmarks, including highways, rivers, or other bodies of water within 5 mi (8 km) of the facility"

Also for reference, NUREG-1555, Standard Review Plans for Environmental Reviews for Nuclear Power Plants, defines vicinity as follows: "For small sites (on the order of 2 km^2), the vicinity is the area encompassed within a radius of 10 km (6 mi)". Note that the FFF site, at 44.6 ha in size, is considerably smaller than 2 km^2 (200 ha). It is proportional then that the vicinity is defined as 5 mi (8 km) for a site of this size.

Therefore, the 5.38-mile radius site region is appropriate and conservatively large.

Meteorology and Air Quality

RAI2-1 ER-AIR-1

Provide estimates of CO2e emissions in metric tons per year for peak years for each phase of the project (construction, operation, transportation of radiological and nonradiological materials, and decommissioning). Compare the estimated emissions to the EPA established thresholds for greenhouse gas emissions in the Tailoring Rule and assess impacts and compare the project's estimated emissions of CO2e by each phase to projected greenhouse gas emissions in Tennessee and the United States. Suggested guidance can be found in NRC's "Interim Staff Guidance on Environmental Issues Associated with New Reactors," COL/ESP-ISG-026.

The requested information is required to enable NRC staff to evaluate greenhouse gas (GHG) emissions and climate change impacts in the EIS following the guidance provided in COL/ESPISG-026.

TRISO-X Response to RAI 2-1 ER-AIR-1

Peak annual greenhouse gas emissions during site preparation and construction are estimated to be 8,900 metric tons CO_{2e}. Peak annual greenhouse gas emissions during facility operations are estimated to be 4,200 metric tons CO_{2e} (based on 2,900 metric tons CO_{2e} from facility operations and 1,300 metric tons CO_{2e} from transportation of radiological and non-radiological materials). The peak annual greenhouse gas emissions during construction are expected to bound the peak annual greenhouse gas emissions during decommissioning.

The above emission estimates are based on information in the Environmental Report such as diesel fuel consumption during construction, truckloads of excavated material, truck waste shipments during construction, truck deliveries and waste shipments during operations, and worker transportation. Emissions from facility operations were also included. The emission estimates for decommissioning are conservative when compared to the guidance in COL/ESP-ISG-026 Attachment 1, Appendix A, which states that equipment emissions estimates for decommissioning are assumed to be one half of those for preconstruction/construction. A CO_2 to total greenhouse gas equivalency factor of 0.991 was used to account for the emissions of other GHGs such as methane (CH_4) and nitrous oxide (N_2O). Conversion from gallons of diesel fuel consumed to CO_{2e} was based on EPA emission factors, in accordance with the guidance in COL/ESP-ISG-026 Attachment 1, Appendix A.

These peak annual greenhouse gas emission estimates are below the 22,680 metric tons CO_{2e} reporting threshold and well below the 68,000 metric tons CO_{2e} threshold for prevention of significant deterioration and Title V permits set in the Greenhouse Gas Tailoring Rule.

The 2023 Annual Energy Outlook, published by the U.S. Energy Information Administration, projects the total U.S. energy-related carbon dioxide emissions through 2050. As of 2022, the total U.S. energy-related carbon dioxide emissions were just under 5 billion metric tons CO_2. By 2050, that figure is expected to be just under 4 billion metric tons CO_2.

The U.S. Energy Information Administration also publishes energy-related carbon dioxide emissions by state. As of 2021, the state of Tennessee produced 92.7 million metric tons CO_2. There do not appear to be comparable projections of future CO_2 emissions at the state level. The peak annual greenhouse gas emissions due to the TRISO-X facility are estimated to be negligible when compared to state and nationwide greenhouse gas emissions.

References:
https://www.eia.gov/outlooks/aeo/pdf/AEO2023_Narrative.pdf
https://www.eia.gov/environment/emissions/state/excel/table1.xlsx

Geology and Soils

RAI2-1 ER-GS-1

Provide a revised version of figure 3.3.3-1, "Geologic Map in the Vicinity of the Horizon Center Site," from the ER that includes the geology west of the proposed FFF Site near the west outfall.

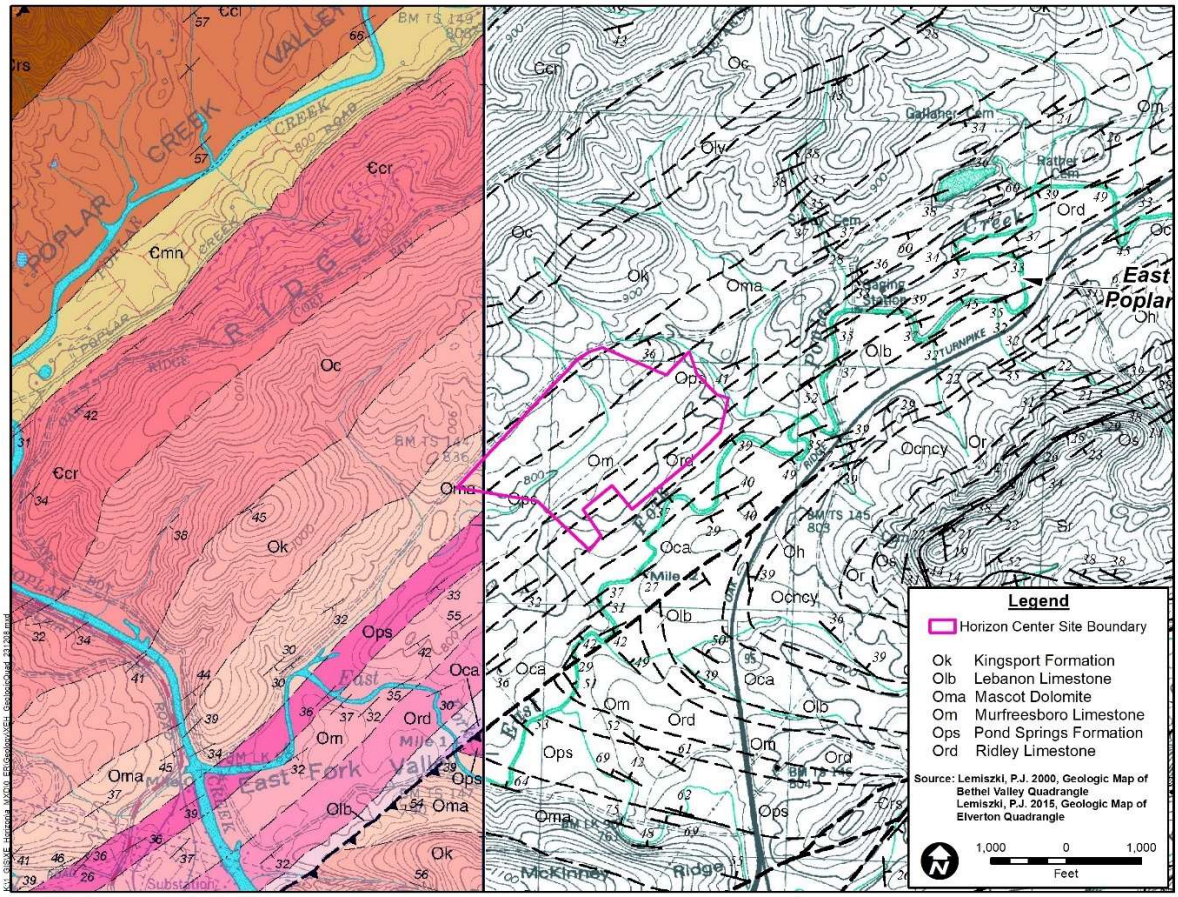
ER figure 3.3.3-1, "Geologic Map in the Vicinity of the Horizon Center Site," does not show the geology on the west side of the proposed FFF Site. Therefore, the Elverton Quadrangle Geology map is not shown. A complete picture of the geology at the FFF Site and vicinity is germane to effectively evaluating stratigraphic and geologic conditions.

This is required under 10 CFR 51.45. Staff developed this RAI with consideration of NUREG1748 Section 5.4.3. An applicant is encouraged, but not required to use the NUREG-1748 when preparing a response. The procedures in NUREG-1748 represent one method to demonstrate compliance with requirements established by legislation and regulations.

Enclosure 1 - RAI Part 2-1 Responses for the TRISO-X Environmental Report and License Application

TRISO-X Response to RAI 2-1 ER-GS-1

ER Figure 3.3.3-1 will be replaced with the new figure below, which includes geology on the west side of the TRISO-X site. Note that the sources of this figure are two separate maps joined together (see the legend), which is why the left side of the figure is in color and the right side of the figure is in grayscale. The colors do not add information to the map, they only provide contrast between formations.



RAI2-1 ER-GS-2

Provide a supplemental figure to figure 3.3.3-2, "Physiography in the Vicinity of the Horizon Center Site," from the ER that includes the site boundary and current USGS topographic mapping details for the proposed FFF Site and vicinity.

The scale within ER Figure 3.3.3-2, "Physiography in the Vicinity of the Horizon Center Site," does is not a large enough for the NRC staff to effectively evaluate of pertinent topographic features in and around the site. For example, it is not clear whether USGS topographic mapping is illustrated on the figure.

This is required under 10 CFR 51.45. Staff developed this RAI with consideration of NUREG1748 Section 5.4.3. An applicant is encouraged, but not required to use the NUREG-1748 when preparing a response. The procedures in NUREG-1748 represent one method to demonstrate compliance with requirements established by legislation and regulations.

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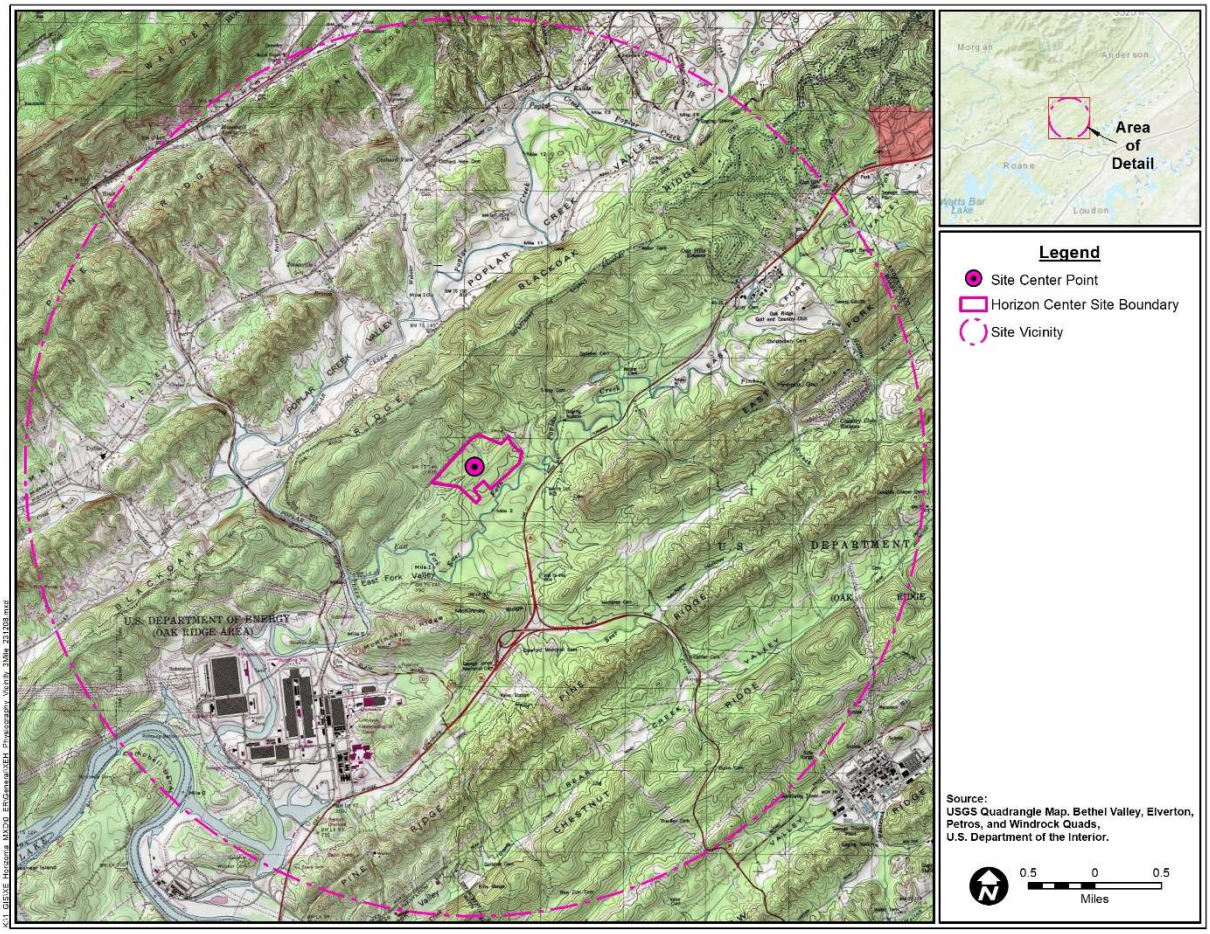
TRISO-X Response to RAI 2-1 ER-GS-2

ER Figure 3.3.3-2 will be replaced with the new figure below which includes a larger scale based on USGS topographic mapping.



Public and Occupational Health and Safety

RAI2-1 ER-POH-1

Provide a map and description of the monitoring locations and methods that would be used to monitoring gaseous effluents to validate compliance with the As Low as Reasonably Achievable (ALARA) goal or 10 millirem per year (mrem/yr) at the restricted area boundary.

TRISO-X has committed in its application to limiting radiation dose to a member of the public at the restricted area boundary by monitoring gaseous effluents prior to discharge and calculating the dose at the restricted area boundary. Because the effluents are released from elevated release points, the restricted area boundary for the purpose of compliance is at the effective release height (i.e., 100 feet). In order to provide accurate reports as required by 10 CFR 70.59, monitoring programs must be designed to provide an independent check of the environmental concentrations to validate that the environmental concentrations are consistent with the calculations.

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The ER explains how compliance with radiological effluent controls will be demonstrated with stack monitoring. The ER does not indicate how TRISO-X plans to provide an independent check of the environmental concentrations to satisfy 10 CFR 20 requirements for radiological environmental monitoring. The routine gaseous effluents and some potential accident-related effluents are planned to be released at a 100-foot elevation. Ground level monitoring at the restricted area boundary does not provide representative sampling of environmental concentrations at the location of the maximum exposed individual, and therefore, cannot provide an independent check of environmental concentrations."

TRISO-X Response to RAI 2-1 ER-POH-1

RAI 2-1 ER-POH-1 seeks clarification related to TRISO-X compliance with 20 CFR 1101(d), the ALARA constraint on air emissions of 10 mrem/year.

To clarify, the 10 mrem/year constraint on air effluent applies to the maximally exposed individual (MEI), not the restricted area boundary. 10 CFR 20.1101(d) "…the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem/year from these emissions."

License Chapter 9, Section 9.2 states, regarding compliance with the air effluent constraint, "Operating and engineered controls are used as necessary to ensure that environmental airborne concentrations of radioactive materials attributable to gaseous effluents are constrained and resultant radiological doses to members of the public comply with the concentration limits and public dose limit specified in 10 CFR 20.1101(d), consistent with guidance in Regulatory Guide 4.20. Dose calculations are performed using nationally recognized methods."

RAI 2-1 ER-POH-1 refers to a requirement for an "independent check" of environmental concentrations and states that the requirement can be found in 10 CFR 70.59 and 10 CFR 20. It goes on to state that, "Ground level monitoring at the restricted area boundary does not provide representative sampling of environmental concentrations at the location of the maximally exposed individual, and therefore, cannot provide an independent check of environmental concentrations."

A review of the requirements in 10 CFR 20, 10 CFR 70.59, and guidance in NRC Regulatory Guides 4.15, 4.16, 4.20, and 8.37 did not reveal a requirement to provide an "independent check" of the environmental concentrations to validate calculations. It is TRISO-X understanding that the reviewer cited 10 CFR 20.1302(a) as specifying that an independent check be performed. 20.1302 is provided below for reference. Certain words are bolded for emphasis.

> §20.1302 Compliance with dose limits for individual members of the public.
>
> (a) The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in §20.1301.

(b) A licensee **shall show compliance** with the annual dose limit in §20.1301 by-

(1) Demonstrating by measurement **or** calculations that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit; **or**

(2) Demonstrating that-

(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in table 2 of appendix B to part 20.

NUREG-1736, Section 3.20.1302 (page 3-72) provides an interpretation of the options listed in 20.1302.

> This section provides licensees with two different methods for showing compliance with the public dose limit of 100 mrem in a year. The first method relies on any combination of calculations and measurements of the dose received by the member of the public receiving the highest dose from the licensed activity.
>
> For licensees whose expected public dose contributions from the licensed operation are significantly below the dose limits, it may be easier to show compliance using the second method. That method relies on showing that two conditions have been met: the concentrations of radioactive material released to the environment, when averaged over a year, do not exceed those listed in Table (2) of Appendix B, …
>
> The concentrations of released materials are to be measured at the boundary of the unrestricted area. For many facilities, this means at the point of release to the atmosphere, such as the top of the stack, for airborne releases…

The following sections document in more detail the TRISO-X approach for compliance with 10 CFR 20.1101(d), and thus compliance with 10 CFR 20.1301. The sections address: definitions, air emission estimates at the boundary of the restricted area (the stack), dose estimates to the MEI, and planned air emissions monitoring.

Definitions:

Restricted Area Boundary: The entire TRISO-X process area is designated as the Restricted Area. The restricted area boundary for gaseous effluent is at the point it is released from the building, or the stack. The effective release height is conservatively set at the stack height of 30.5 meters.

Controlled Area Boundary: The Controlled Area boundary is the fenced site boundary. The shortest distance from the stack to the site boundary is 72 meters.

Maximally Exposed Individual: Considering the effective stack height of 30.5 meters and using HotSpot, Version 3.1.2-February 11, 2020, the maximum dose distance for each stability class is shown below:

Table 1 Distance to the MEI

Stability Class	Max Dose Distance, m
A	110
B	180
C	270
D	430
E	850
F	1900
G	1900

Air emission estimates at the boundary of the restricted area (the stack)

10 CFR 20.1302(b)(2)(i) allows the licensee to comply with the public dose limit by demonstrating that the annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to Part 20. Again, NUREG-1736 states, “For many facilities, this means at the point of release to the atmosphere, such as the top of the stack, for airborne releases, and at the point of discharge to a body of water, for liquid releases.”

Regulatory Guide 4.20, Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees Other Than Power Reactors, Section 2(a), Calculation of Dose to the Member of the Public Likely to Receive the Highest Dose from Airborne Effluents, states,

> The concentrations of radionuclides limited by the stochastic ALI in Table 2, Column 1, would produce an annual dose of 0.5 mSv (50 mrem) to a reference adult if the radionuclides are inhaled or ingested continuously over the course of a year. The licensee can thus demonstrate that it meets the constraint if the annual average radionuclide concentration at the point of release is less than 20 percent of the “air” values in Table 2 and if the radionuclides present in the effluent are limited by the stochastic ALI.”

The radionuclides in the anticipated TRISO-X source term are limited by the stochastic ALI. Therefore, compliance with 20.1101(d), and thus compliance with 20.1302(b)(2)(i), is demonstrated if the average annual activity concentrations at the stack (the boundary of the unrestricted area) is less than 20% of the Table 2, Column 1 values.

The TRISO-X annual activity concentration was estimated using 16 MTU mass balance estimates of radiological effluent considering a less than 20% enriched uranium source term, and the planned containment types and resulting annual air volumes. Crediting 2 of the 3 planned HEPA filtration stages resulted in an air effluent concentration less than 10% (5 mrem) of the most restrictive table 2 limit for Uranium (U-234) at the boundary of the restricted area (the stack).

The sum of the fractions approach is also considered using an isotopic mix weighted for the anticipated source term. Crediting 2 stages of HEPA filtration, the sum of the fractions for the source term is less than 1.

Dose Estimates to the MEI

Although not required to demonstrate compliance with 20.1101(d), Hotspot was used to calculate the dose at the “Max Dose Distance” for each stability class and at the shortest site

boundary distance (72 meters). The site-specific Hotspot input parameters included the effective stack height and the annual activity for each isotope weighted for the source term. FGR 13 solubility S was used for the dose conversion factor, and, to maximize the amount of material transported, the respirable and non-respirable deposition velocities were set to zero. All other parameters were set to default values. The results are provided below.

Table 2 MEI and Fenceline Dose

Stability Class	Max Dose Distance, m	Max Dose, rem	Dose at Fenceline (72 m)
A	110	9.20E-06	6.10E-06
B	180	7.70E-06	3.00E-07
C	270	7.00E-06	3.80E-10
D	430	5.50E-06	3.60E-15
E	850	3.10E-06	0
F	1900	1.60E-06	0
G	1900	2.90E-07	0

As demonstrated in Table 2 above, the dose calculated at all MEI distances and at the site boundary is orders of magnitude below the 10 CFR 20.1101(d) constraint of 1.00E-02 rem/year (10 mrem/year).

Planned Air Emissions Monitoring

TRISO-X will perform continuous air monitoring at the stack to demonstrate compliance with the public dose limits as specified in 20.1101 and 20.1301. The method of compliance is described in 20.1302(b)(2)(i) for compliance with 20.1301; by demonstrating that the annual average concentrations of radioactive material released in gaseous…effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to Part 20, and Section 2(a) of NRC Regulatory Guide 4.20 for compliance with 10 CFR 20.1101(d); demonstrating that the average annual activity concentrations at the stack (the boundary of the unrestricted area) is less than 20% of the Table 2, Column 1 values.

Perimeter air monitoring will also be performed at select locations at the site boundary. This monitoring is done to document the absence of ground level emissions under normal operating conditions, and to measure the off-site impact in the event of a ground level air emission. A minimum of 2 monitoring stations will be optimally located considering the predominant wind directions and physical access constraints. A map showing the locations of monitoring stations will be provided with the RAI responses for License Chapter 9, *Environmental Safety*.

Action levels for monitoring results will be established and documented in implementing procedures. Implementing procedures will also establish the fraction of samples that will go off-site for isotopic analysis by an accredited laboratory.

Enclosure 1 - RAI Part 2-1 Responses for the TRISO-X Environmental Report and License Application

Transportation

RAI2-1 ER-TR-1

Provide a description of the traffic study that TRISO-X is conducting as required by the City of Oak Ridge and what results and recommendations might come from the study that TRISO-X would be required to follow.

Section 3.2.2 of the ER, “Transportation Routes,” discusses TRISO-X’s assessment of transportation routes associated with the FFF. Within this section TRISO-X notes they are conducting a traffic study for the project, as required by the City of Oak Ridge. The ER further notes that TRISO-X would abide by the results and any recommendations from the City of Oak Ridge governing body. However, the ER does not discuss what the traffic study would entail, what type of activities the City of Oak Ridge may recommend, and whether TRISO-X would be required to abide by the recommendations, and if so, how that could change the potential impacts from the proposed project.

TRISO-X Response to RAI 2-1 ER-TR-1

The traffic study for the TRISO-X FFF project is now complete. The traffic study analyzed the impact of traffic during the Construction and Operational phases of the facility development within the study area. The study area encompassed the unsignalized intersections of Novus Drive and Imperium Drive along SR-95 (Oak Ridge Turnpike) and Novus Drive at Palladium Way. The traffic study concludes that a left turn lane is recommended at the facility entrance on Renovare Boulevard and this recommendation will be implemented. In addition, acceleration and deceleration lanes along Renovare Boulevard will be provided at the facility entrance for right hand turns. The other roads and intersections in the study area are acceptable and do not require modifications.

Accident Impacts

RAI2-1 ER-ACC-1

Provide concise summary with the results for high or intermediate consequence radiological and chemical accidents. The information should include results for unmitigated and mitigated total effective dose equivalent (TEDE) doses (in rems) and chemical concentrations (mg/cc and soluble U in mg) at the following locations: site boundary, the Maximally Exposed Offsite Individual (MEOI) location, and the location of maximum concentration for the effective release height of the proposed facility (e. g., 100-foot stack plus plume rise). Results should be provided for releases at both ground level and the elevated release, according to the accident scenario. Comparison to the dose consequences (TEDEs) and CHEMs (acute exposure guideline levels [AEGL], emergency response planning guidelines [ERPG], or temporary emergency exposure levels [TEEL]) consequences to the Public/Environment and Worker presented in accordance with 10 CFR 70.61 (“Radiological and Chemical Consequence Exposure Levels”) should also be provided. Additionally, for the mitigated results, provide the associated preventative and mitigative controls (items relied on for safety [IROFS]) that were credited to reduce either the frequency or the consequence of each design basis accident (DBA).

Section 4.12.2.3 of the ER, “Environmental Effects of Accidents,” provides a limited description of the environmental impacts associated with postulated (or design basis) radiological and

hazardous chemical accidents that might occur at the proposed TRISO-X FFF and lacks specificity of credited controls and design detail for IROFS that would be implemented to prevent or mitigate such accidents.

This information is required under 10 CFR 70.61 and 10 CFR 51.45 and is needed by staff to make an environmental impact determination.

TRISO-X Response to RAI 2-1 ER-ACC-1

The ISA radiological and chemical exposure calculations used a different dispersion and associated release height than those used to characterize air effluents from normal operations in the Environmental Report. The ISA radiological and chemical exposure calculations were performed with a dispersion coefficient using release heights of 0.0 meters and 9.81 meters (conservative height, less than actual stack height). This provides a conservative dispersion that results in the highest concentration occurring within the controlled area for both release heights. The ISA maximum exposure would occur within the controlled area. However, since members of the public are not authorized to be in the controlled area, the offsite maximum exposed individual is conservatively assumed to be located at the controlled area boundary fence. The tables below provide a concise summary of the results for offsite radiological dose, environmental effluent, and chemical exposures. The ISA chemical exposures are based on indoor evaporating spills or pressurized gas releases (i.e., solution spills all remain within the building under ISA applicability). The tables also include a reference to the ISA Summary Section 6, Table 6-1.24 to provide a cross reference to the applicable IROFS for each accident sequence. ISA Summary Section 6, Table 6-1.24 provides a reference to the accident sequence within ISA Summary Section 4, Table 4-1.24.

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Table 1 Uranium Release to the Public

Release Scenario	Maximum Offsite Dose (rem)	Intermediate TEDE (rem)	High TEDE (rem)	ISA Consequence Level	IROFS Number (Table 6-1.24)
HMDSO fire leading to uranium release from multiple vessels	Assumed High Consequence (> 25 rem)	5	25	High	CHRA-30 CHRA-31

Table 2 Uranium Release to the Environment

Release Scenario	Material-at-Risk (kg)	Intermediate	ISA Consequence Level	IROFS Number (Table 6-1.24)
HMDSO fire leading to uranium release from multiple vessels	60 kg	5000 times Part 20 Appendix B over 24 hours	Intermediate	CHRA-30 CHRA-31

Table 3 Chemical Release to the Public

Release Scenario	ISA Summary Table Number and Calculation ID[1]	Maximum Offsite Concentration (mg/m^3)	AEGL-1 or PAC-1 (mg/m^3)	AEGL-2 or PAC-2 (mg/m^3)	AEGL-3 or PAC-3 (mg/m^3)	ISA Consequence Level	IROFS Number (Table 6-1.24)
Acetic Acid liquid	Table 4-2.7 MR10-1b	3.81E+01	12	86	610	Intermediate	CHRA-30 CHRA-31 CHRA-42 CHRA-43 CHRA-44
Nitric Acid liquid	Table 4-2.2 AP01-1	6.64E-01	0.4	77.2	437.2	Intermediate	CHRA-30 CHRA-31 CHRA-42 CHRA-43 CHRA-44
MTS liquid	Table 4-2.5 TF04-5	1.31E+01	3.7	85	1281	Intermediate	CHRA-10 CHRA-11
Carbon Monoxide Gas	Table 4-2.4 KC03-2	2.63E+02	86	171	1944	High	CHRA-1 CHRA-2
MTS Gas	Table 4-2.5 TF04-4	5.32E+01	3.7	85	1281	Intermediate	CHRA-10 CHRA-11
HMDSO liquid spill resulting in fire leading to Nitric Acid release	Table 4-2.2 AP01-3	1.24E+02	0.4	77.2	437.2	High	CHRA-30 CHRA-31 CHRA-42 CHRA-43 CHRA-44

[1]Provides Material-at-Risk quantity.