



NUREG-2263

# **Environmental Impact Statement for the Construction Permit for the Kairos Hermes Test Reactor**

Draft Report for Comment

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NUREG-2263

United States Nuclear Regulatory Commission  
*Protecting People and the Environment*

# **Environmental Impact Statement for the Construction Permit for the Kairos Hermes Test Reactor**

## **Draft Report for Comment**

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Office of Nuclear Material Safety and Safeguards

1

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## COVER PAGE

2   **Responsible Agency:** U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety  
3   and Safeguards

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5   *Reactor, Draft Report for Comment*

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13

## ABSTRACT

14   The U.S Nuclear Regulatory Commission (NRC) has prepared this draft environmental impact  
15   statement (EIS) in response to an application submitted by Kairos Power, LLC (Kairos) for a  
16   construction permit (CP) for a non-power test reactor termed Hermes at a site in Oak Ridge,  
17   Tennessee. Kairos plans to build and operate Hermes to demonstrate key elements of the  
18   Kairos Power Fluoride Salt-Cooled, High Temperature Reactor technology for possible future  
19   commercial deployment. This draft EIS includes the analysis that evaluates the environmental  
20   impacts of the proposed action and considers the following two alternatives to the proposed  
21   action: (1) the no-action alternative (i.e., the CP is denied) and (2) building the proposed  
22   Hermes non-power test reactor at a site near Idaho Falls, Idaho.

23   After weighing the environmental, economic, technical, and other benefits against environmental  
24   and other costs, and considering reasonable alternatives, the NRC staff recommends, unless  
25   safety issues mandate otherwise, that the NRC issue the CP to Kairos. The NRC staff based its  
26   recommendation on the following factors:

- 27   • the NRC staff's review of Kairos' environmental report (included as part of the CP  
28   application) and associated responses from Kairos to requests from the NRC staff for  
29   clarifying information;
- 30   • the NRC staff's review of comments received as part of the scoping process;
- 31   • the NRC staff's communications with, and scoping comments received from, Federal, State,  
32   and local agencies, as well as Tribal officials; and
- 33   • the NRC staff's independent environmental review.

34   The NRC's staff's recommendation in this draft EIS is tentative. Before identifying a final  
35   recommendation in the final EIS, the NRC staff will also consider comments received on the  
36   draft EIS from Federal, State, local, and Tribal officials, and members of the public.

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## EXECUTIVE SUMMARY

### 2 BACKGROUND

3 By letter dated September 29, 2021, Kairos Power, LLC (Kairos) submitted an application to the  
4 U.S. Nuclear Regulatory Commission (NRC) for a construction permit (CP) pursuant to Title 10  
5 of the *Code of Federal Regulations* Part 50 (10 CFR Part 50, TN249) that would allow  
6 construction of a non-power test reactor termed Hermes on a 185-ac site in Oak Ridge,  
7 Tennessee (Kairos 2021-TN7879). The Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.*  
8 TN663) authorizes the NRC to issue CPs for nuclear testing facilities. To issue a CP, the NRC  
9 is required to consider the environmental impacts of the proposed action under the National  
10 Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*, herein referred to as NEPA, TN661).  
11 The NRC's environmental protection regulations that implement NEPA in 10 CFR Part 51  
12 (TN250) describe several types of actions that require an environmental impact statement (EIS).  
13 Issuing a CP for a nuclear testing facility is identified in 10 CFR 51.20 (TN250) as one type of  
14 action that requires an EIS.

15 Upon acceptance of the application, the NRC staff began the environmental review process  
16 described in 10 CFR Part 51 (TN250) by publishing a Notice of Intent in the *Federal Register*  
17 (87 FR 9394-TN7885) to prepare an EIS and to conduct scoping activities. In preparation of this  
18 draft EIS, the NRC staff performed the following:

- 19 • conducted a virtual public outreach and EIS scoping meeting on March 23, 2022;
- 20 • conducted a virtual site audit in March 2022 addressing proposed and alternative sites;
- 21 • reviewed Kairos's environmental report submitted as part of the application;
- 22 • contacted Federal, State, and local agencies, as well as Tribal officials;
- 23 • conducted a review using guidance in Final Interim Staff Guidance Augmenting NUREG-  
24 1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-  
25 Power Reactors: Format and Content," for Licensing Radioisotope Production Facilities and  
26 Aqueous Homogeneous Reactors; and Part 2, "Guidelines for Preparing and Reviewing  
27 Applications for the Licensing of Non-Power Reactors: Standard Review Plan and  
28 Acceptance Criteria"; and
- 29 • considered public comments received during the EIS scoping process.

### 30 PROPOSED ACTION

31 The proposed Federal action is for the NRC to decide whether to issue a CP to Kairos under 10  
32 CFR Part 50 (TN249) that would allow construction of the Hermes non-power test reactor. If the  
33 NRC were to issue a CP, Kairos could build the proposed reactor on a 185-acre site in the  
34 Heritage Center Industrial Park of the East Tennessee Technology Park in the City of Oak  
35 Ridge, Tennessee. The East Tennessee Technology Park is an industrial park established by  
36 the City of Oak Ridge on land formerly owned by the U.S. Department of Energy (DOE). The  
37 site was formerly occupied by DOE Buildings K-31 and K-33, which were both part of the former  
38 Oak Ridge Gaseous Diffusion Plant. DOE ceased operation of the Oak Ridge Gaseous  
39 Diffusion Plant in 1986. Both DOE buildings were since razed, and DOE has remediated the  
40 land environmentally and released it for industrial reuse.

1      Issuance of a CP is a separate licensing action from issuance of an operating license (OL),  
2      which allows operation of facilities built pursuant to a CP. If the NRC issues a CP, then Kairos  
3      would still have to obtain an OL before being able to operate the Hermes reactor. To obtain an  
4      OL, Kairos would have to submit a separate application pursuant to NRC requirements and  
5      receive the license before operating the reactor. To conduct a complete and effective  
6      environmental review, this EIS addresses the potential environmental impacts from the full life  
7      cycle of the Hermes reactor, including its construction, operation, and decommissioning. If,  
8      however, Kairos were to apply for an OL, the NRC staff would still have to prepare a  
9      supplement to this EIS in accordance with 10 CFR 51.95(b) (TN250).

## 10     PURPOSE AND NEED FOR ACTION

11    The purpose and need of this proposed Federal action is to allow Kairos to build and operate a  
12   non-power test reactor to demonstrate key elements of the Kairos Power Fluoride Salt-Cooled,  
13   High Temperature Reactor technology for possible future commercial deployment. Operation of  
14   the Hermes reactor would not generate any power for sale or distribution. The technology is an  
15   advanced nuclear reactor technology that leverages TRI-structural ISOtropic (TRISO) particle  
16   fuel in pebble form combined with a low-pressure fluoride salt coolant. The Hermes reactor  
17   would support Kairos' reactor development program, which relies on learning and risk reduction  
18   by narrowing the design space through progressive test cycles. Construction and operation of  
19   the Hermes reactor would also provide validation and qualification data to support potential  
20   future commercial reactors using the Kairos Power Fluoride Salt-Cooled, High Temperature  
21   Reactor technology.

22    The determination of need and the decision to build a test reactor such as Hermes are at the  
23   discretion of applicants such as Kairos. This definition of purpose and need reflects the NRC's  
24   recognition that, unless there are findings in the safety review required by the Atomic Energy  
25   Act of 1954 (TN663), as amended, or findings in the environmental analysis under NEPA that  
26   would lead the NRC to reject a CP application, the agency does not have a role in the planning  
27   decisions as to whether a particular test reactor should be constructed and operated.

## 28     ENVIRONMENTAL IMPACTS OF CONSTRUCTION, OPERATIONS, AND 29   DECOMMISSIONING

30    The EIS evaluates the potential environmental impacts of the proposed action. The  
31   environmental impacts from the proposed action are designated as SMALL, MODERATE, and  
32   LARGE, as presented in the final interim staff guidance to NUREG-1537:

33    **SMALL:** Environmental effects are not detectable or are so minor that they will neither  
34   destabilize nor noticeably alter any important attribute of the resource. In assessing radiological  
35   impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the  
36   agency's regulations are considered SMALL.

37    **MODERATE:** Environmental effects are sufficient to alter noticeably, but not to destabilize,  
38   important attributes of the resource.

39    **LARGE:** Environmental effects are clearly noticeable and are sufficient to destabilize important  
40   attributes of the resource.

1 Table ES-1 summarizes the NRC's staff's findings on the level of direct, indirect, and cumulative  
2 impacts on environmental resources from the construction, operation, and decommissioning of  
3 the proposed Hermes project.

#### 4 **ALTERNATIVES**

5 The NRC staff considered the environmental impacts associated with the following alternatives  
6 to constructing the Hermes non-power test reactor project at the proposed site in Oak Ridge:

- 7 • the no-action alternative; and  
8 • construction, operation, and decommissioning of the Hermes non-power test reactor at an  
9 alternative site, termed the Eagle Rock alternative site, near Idaho Falls, Idaho.

10 The NRC staff considered possible alternative sites, alternative layouts of proposed facilities  
11 within a site, modification of existing facilities instead of building new facilities, alternative  
12 technologies, and alternative transportation methods. The NRC staff determined that there  
13 were no other reasonable alternatives that warranted detailed consideration in the EIS.

14 The NRC staff evaluated each alternative using the same resource areas that were used in  
15 evaluating impacts from the proposed action. The NRC staff determined that the no-action  
16 alternative would result in SMALL impacts to all resource areas. However, the no-action  
17 alternative does not fulfill the action's purpose and need. The NRC staff determined that  
18 construction, operation, and decommissioning of the Hermes non-power test reactor project at  
19 the Eagle Rock alternative site would result in only SMALL impacts for most affected resources,  
20 but that it would result in MODERATE impacts to land use and visual resources, ecological  
21 resources, and historic and cultural resources. The proposed action, which would also meet the  
22 purpose and need but result in only SMALL environmental impacts to all affected resources,  
23 would therefore be the environmentally preferable action. The proposed site in Oak Ridge  
24 allows for siting the Hermes non-power test reactor project while disturbing only previously  
25 disturbed soils with a history of past industrial development, while avoiding natural vegetation,  
26 wetlands, surface water features, agricultural land, and shallow subsurface cultural resources.

#### 27 **RECOMMENDATION**

28 After weighing the environmental, economic, technical, and other benefits against environmental  
29 and other costs, and considering reasonable alternatives, the NRC staff recommends, unless  
30 safety issues mandate otherwise, that the NRC issue the CP to Kairos. The NRC staff based its  
31 recommendation on the following factors:

- 32 • the NRC staff's review of Kairos' environmental report (included as part of the CP  
33 application) and associated responses from Kairos to requests from the NRC staff for  
34 clarifying information;  
35 • the NRC staff's review of comments received as part of the scoping process;  
36 • the NRC staff's communications with, and scoping comments received from, Federal, State,  
37 and local agencies, as well as Tribal officials; and  
38 • the NRC staff's independent environmental review.

39 The NRC's staff's recommendation in this draft EIS is tentative. Before identifying a final  
40 recommendation in the final EIS, the NRC staff will also consider comments received on the  
41 draft EIS from Federal, State, local, and Tribal officials, and members of the public.

1      **Table ES-1   Summary of Environmental Impacts from Construction, Operation, and**  
 2      **Decommissioning of Proposed Hermes Facilities**

Resource Area	Summary of Impact	Impact Level
Land use and visual resources	Temporary disturbance of 138 ac of land previously occupied by industrial DOE buildings. Permanent occupation of 30 ac of the same land. Limited land use options for the entire 185-ac Hermes site, which would be designated as an exclusion area throughout operations. Site is within established industrial park. Setting is already industrial and of low scenic quality. Facilities would have an industrial appearance compatible with an existing industrial park. Hermes project is compatible with existing City of Oak Ridge zoning.	SMALL
Air quality and noise	Air emissions of criteria pollutants would be below 100 tons per year (TPY), and hazardous air pollutants would be below 10 TPY individually and 25 TPY combined. Emissions would comply with non- <i>Title V</i> permitting requirements. Standard control measures would be used to mitigate fugitive dust releases.	SMALL
Hydrogeology and water resources	No disturbance of geological features of economic or natural value. Disturbances limited to previously disturbed soils. Best management practices (BMPs) would be employed for soil erosion and sediment control. Water demands would be met through municipal or commercial suppliers. No use of groundwater and no direct use of surface water. No cooling towers, ponds, or reservoirs. Wastewater discharged for treatment to municipal wastewater treatment facilities. Limited, temporary dewatering of building excavations for construction. Dewatering water would be dispositioned in accordance with DOE requirements per the quit claim deed for the site. Stormwater would be managed using BMPs.	SMALL
Ecological resources	Ground disturbance would be limited to areas of previously disturbed soils that are unvegetated or support only ruderal early successional vegetation. No disturbances to forest cover or other natural vegetation growing on natural soils, wetlands, surface waters, shorelines, or riparian lands. No Section 404 permit required. BMPs to control stormwater runoff that might reach wetlands or aquatic habitats. Localized, minor increases in noise may affect wildlife, but area wildlife already experiences industrial noise. Limited potential for wildlife to collide with new structures or be injured by vehicles. The Federally endangered gray bat ( <i>Myotis grisescens</i> ) and Indiana bat ( <i>M. sodalis</i> ) and Federally threatened northern long-eared bat ( <i>M. septentrionalis</i> ) are known to occur in the Oak Ridge area and may forage transiently on the site, but no potential roosting or breeding habitat would be disturbed and foraging individuals can be expected to avoid areas of human activity.	SMALL

<b>Resource Area</b>	<b>Summary of Impact</b>	<b>Impact Level</b>
Historic and cultural resources	No effect to historic properties as none are located in direct effects area of potential effects. Ground disturbance limited to areas of extensive past soil disturbance with little potential for remaining archaeological resources. Kairos would also develop an Archaeological Monitoring and Discovery Plan establishing stop work and notification procedures to address unexpected discovery of human remains or archaeological material in compliance with deed requirements and Tennessee State law. The National Register of Historic Places eligible Manhattan Project National Historical Park is located in the indirect effects area of potential effects but will not be adversely affected, because the setting of the proposed Kairos project is in keeping with the current setting of the Manhattan Project National Historical Park.	SMALL
Socioeconomics and environmental justice (EJ)	Construction of Hermes would involve an average of 212 site workers per year over a two-year period, with an estimated peak of 425 workers. Staffing during the four-year operation would average 38 workers per weekday (68 full time positions). Decommissioning would involve an estimated peak employment level of 340 workers. These small numbers of workers would not substantially affect employment levels in the surrounding area, but the demand for some skilled labor might compete with other planned technology projects. The small size of the Hermes project and the distance of the site from the closest census blocks with populations meeting EJ criteria (over 8 mi away) indicate little potential for EJ effects.	SMALL
Human health	Site was formerly occupied by buildings part of the DOE Oak Ridge Gaseous Diffusion Plant used to enrich uranium, but DOE has already razed the buildings and remediated the site for unrestricted industrial reuse. DOE retains responsibility for remediation following any unanticipated discovery of legacy wastes. Based on information in the CP application, the NRC staff expects that radiological releases, doses to the public, and occupational doses would be less than the limits established for protection of human health and the environment in 10 CFR Part 20 (TN283). Applicant would implement normal safety practices contained in Occupational Safety and Health Administration regulations in 29 CFR Part 1910 (TN654) to protect occupational health. Emissions would comply with the Resource Conservation and Recovery Act (TN1281), Clean Air Act (TN1141), and other environmental regulations.	SMALL
Nonradiological waste management	Kairos would develop and implement a plan to manage wastes generated by the Hermes facilities. Management of solid waste, including construction and demolition waste, would involve waste reduction efforts, recycling, and BMPs. Liquid wastes would be discharged for municipal treatment at a wastewater treatment plant or trucked offsite for proper disposal. Gaseous emissions would comply with Tennessee Department of Environment and Conservation regulations.	SMALL

<b>Resource Area</b>	<b>Summary of Impact</b>	<b>Impact Level</b>
Uranium fuel cycle and radiological waste management	Low quantity of uranium used during the four-year operational period. TRISO fuel processes (including enrichment and fuel fabrication) are bounded by Table S-3, developed by NRC to protect human health and the environment. Environmental impacts from storage of spent TRISO fuel from Hermes is bounded by the analysis in the Continued Storage Generic EIS. Estimated volume of low-level radioactive waste (LLRW) is less than or comparable to that from a light water reactor, and the NRC staff determined that there is adequate capacity at LLRW disposal sites and that LLWR sites would accept the LLRW from Hermes. Onsite storage of spent TRISO fuel would have to meet the same regulatory requirements as currently licensed light water reactors.	SMALL
Transportation	Transportation of radioactive fuels and wastes to and from Hermes would be performed in compliance with U.S. Department of Transportation and NRC regulations and constitute only a small percentage of the total materials of these types shipped each year.	SMALL
Accidents	NRC staff is conducting an independent review of the consequences of accidents and will document it in its Safety Evaluation Report. To receive a CP, the Hermes test reactor would have to meet the NRC requirements for postulated accidents, where potential doses at the exclusion area boundary and in the low population zone are below the dose reference values of 10 CFR Part 100 (TN282) for test reactor siting. Additionally, as another indication of the low-level of environmental impacts, the nearest resident dose from accidents is also below the radiation dose limits for individual members of the public in 10 CFR 20.1301(a) (TN283).	SMALL
Climate change	Climate change is a global phenomenon that the construction, operation, and decommissioning of the proposed Hermes test reactor would not appreciably alter. None of the impact conclusions in this draft EIS for the Hermes facilities would change as a result of climate change.	SMALL

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## ABBREVIATIONS AND ACRONYMS

2	°F	degree(s) Fahrenheit
3	%	percent
4	ac	acre(s)
5	ARDP	Advanced Reactor Demonstration Program
6	AECOM	AECOM Technical Services, Inc.
7	ADAMS	Agencywide Document Access and Management Systems
8	ACS	American Community Survey
9	APE	Area of potential effects
10	Atlas facility	Kairos Atlas Fuel Fabrication Facility
11	dBA	A-weighted sound levels
12	BMP	best management practice
13	BA	biological assessment
14	C	pyrolytic carbon
15	CO <sub>2</sub>	carbon dioxide
16	CO <sub>2</sub> eq	carbon dioxide equivalent
17	CO <sub>2</sub> eq/kWh	carbon equivalent per kilowatt hour
18	CFPP	Carbon Free Power Project
19	CO	carbon monoxide
20	CBG	Census Block Group
21	cm	centimeter(s)
22	CAA	Clean Air Act
23	CH <sub>4</sub>	methane
24	CRN	Clinch River Nuclear
25	CFR	<i>Code of Federal Regulations</i>
26	CP	construction permit
27	CEQ	Council on Environmental Quality
28	ft <sup>3</sup>	cubic foot
29	ft <sup>3</sup> /yr	cubic foot per year
30	m <sup>3</sup>	cubic meter(s)
31	cy or yd <sup>3</sup>	cubic yard(s)
32	Ci/m <sup>3</sup>	curie(s) per meter cubed
33	Ci/yr	curie(s) per year
34	DHRS	Decay Heat Removal System
35	dB	decibel(s)
36	DOE	U.S. Department of Energy
37	DBA	design basis accidents
38	EA	environmental assessment
39	EAB	exclusion area boundary
40	EIS	environmental impact statement
41	EPA	U.S. Environmental Protection Agency
42	ER	environmental report

1	ESA	Endangered Species Act
2	ETTP	East Tennessee Technology Park
3	FR	<i>Federal Register</i>
4	ft	foot/feet
5	FWS	U.S. Fish & Wildlife Service
6	gal	gallon(s)
7	gpd	gallon(s) per day
8	gpm	gallon(s) per minute
9	GWd/MTU	gigawatt-day(s) per metric ton of uranium
10	GWP	global warming potential
11	g	gram(s)
12	g/MT-km	gram per metric ton-kilometer
13	g/T-mi	gram per ton-mile
14	GCRP	U.S. Global Change Research Program
15	GHGs	greenhouse gases
16	HAP	hazardous air pollutant
17	Heritage Center	Heritage Center Industrial Park
18	HALEU	High-Assay Low Enriched Uranium
19	Horizon Center	Horizon Center Industrial Park
20	hr/yr	hour(s) per year
21	in	inch(s)
22	IpaC	Information for Planning and Consultation
23	ISFSI	Independent Spent Fuel Storage Installations
24	Kairos	Kairos Power, LLC
25	km	kilometer(s)
26	km/L	kilometer(s) per liter
27	Pb	lead
28	LOS	Level of Service
29	LR	License Renewal
30	LWR	Light water reactors
31	LPZ	Low Population Zone
32	LLRW	low-level radioactive waste
33	MEI	maximally exposed individual
34	MHA	maximum hypothetical accident
35	Mwe	megawatt(s) electric
36	MWt	megawatt(s) thermal
37	MWd/MT	megawatt(s)-day per metric ton
38	MWh	megawatt-hour
39	MOA	Memorandum of Agreement
40	m	meter(s)
41	MT	metric ton(s)
42	MT CO <sub>2</sub> eq	metric ton(s) of carbon dioxide equivalent
43	MTU	metric ton(s) of uranium
44	MTU/yr	metric ton(s) of uranium per year

1	$\mu\text{Ci/mL}$	micro-curie(s) per milliliter
2	$\mu\text{m}$	micrometer(s)
3	mi	mile(s)
4	mi/gal	mile(s) per gallon
5	mph	mile(s) per hour
6	mg	million gallon
7	mgd	million gallon(s) per day
8	mrem	millirem (s)
9	mrem/yr	millirem (s) per year
10	NAAQS	National Ambient Air Quality Standards
11	NEPA	National Environmental Policy Act of 1969
12	NHPA	National Historic Preservation Act
13	NHP	National Historical Park
14	NIOSH	National Institute of Occupational Safety and Health
15	NPS	National Park Service
16	NPDES	National Pollutant Discharge Elimination System
17	NRHP	National Register of Historic Places
18	$\text{NO}_2$	nitrogen dioxide
19	NPP	nuclear power plant
20	NRC	U.S. Nuclear Regulatory Commission
21	$\text{O}_3$	ozone
22	ORGDP	Oak Ridge Gaseous Diffusion Plant
23	ORNL	Oak Ridge National Laboratory
24	ORR	Oak Ridge Reservation
25	OL	operating license
26	OSHA	U.S. Occupational Safety and Health Administration
27	PM	particulate matter
28	PHSS	pebble handling and storage system
29	PCB	polychlorinated biphenyl
30	lb	pound(s)
31	lb/MWh	pound(s) per megawatt-hour
32	PSAR	preliminary safety analysis report
33	PSD	Prevention of Significant Deterioration
34	RRY	reference reactor-year
35	ROI	region of interest
36	SAFSTOR	SAFe STORage
37	SER	safety evaluation report
38	Sequoyah	Sequoyah Nuclear Plant
39	SiC	silicon carbide
40	$\text{mi}^2$	square miles
41	State Route	SR
42	scf	standard cubic feet
43	SWPP	Storm Water Pollution Prevention Plan
44	$\text{SO}_2$	sulfur dioxide

1	SF <sub>6</sub>	sulfur hexafluoride
2	TDEC	Tennessee Department of Environment and Conservation
3	THC	Tennessee Historical Commission
4	TVA	Tennessee Valley Authority
5	TPY	ton(s) per year
6	TEDE	total effective dose equivalent
7	TRISO	TRI-structural ISOtropic
8	TMS	tritium management system
9	uranium-235	U-235
10	UC	uranium carbide
11	UC <sub>2</sub>	uranium dicarbide
12	UO <sub>2</sub>	uranium dioxide
13	UF <sub>6</sub>	uranium hexafluoride
14	VP	Versa-Pac
15	VOC	volatile organic compounds
16	WCS	Waste Control Specialists, LLC
17	WWTP	Wastewater Treatment Plant
18	Watts Bar	Watts Bar Nuclear Plant
19		
20		

## 1 1.0 INTRODUCTION

2 By letter dated September 29, 2021, Kairos Power, LLC (Kairos) submitted Part 1 of a two-part  
3 application to the U.S. Nuclear Regulatory Commission (NRC) for a construction permit (CP)  
4 pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 (TN249), that would  
5 allow construction of a non-power test reactor termed Hermes on a 185 acre (ac) site located in  
6 Oak Ridge, Tennessee (Kairos 2021-TN7879). Section 104 of the Atomic Energy Act of 1954,  
7 as amended, (42 U.S.C. 2011 *et seq.* TN663) and its implementing regulations authorize the  
8 NRC to issue CPs for testing facilities. To issue a CP, the NRC is required to consider the  
9 environmental impacts of the proposed action under the National Environmental Policy Act of  
10 1969 (NEPA; 42 U.S.C. 4321 *et seq.* TN661, herein referred to as NEPA). The NRC's  
11 environmental protection regulations that implement NEPA in 10 CFR Part 51 (TN250) describe  
12 several types of actions that would require an environmental impact statement (EIS). CPs and  
13 operating licenses (OLs) for test facilities are identified in 10 CFR 51.20 (TN250) as actions that  
14 require an EIS.

15 Applicants for NRC licenses are required under 10 CFR 51.45 (TN250) to submit an ER  
16 containing a description of the proposed project, a statement of its purposes, a description of  
17 the affected environment, and specific information needed for by the NRC staff to evaluate the  
18 potential environmental impacts. After initially submitting Part 1 of the Kairos Hermes  
19 application (consisting of its preliminary safety analysis report [PSAR]), on October 31, 2021,  
20 Kairos submitted an environmental report (ER) with information needed to assess potential  
21 environmental impacts from the CP licensing action (Kairos 2021-TN7880). By letters dated  
22 February 10, February 18, and March 1, 2022, Kairos provided supplemental information  
23 regarding its CP application, including the ER (Kairos 2022-TN7881, Kairos 2022-TN7882,  
24 Kairos 2022-TN7883). References to the Kairos ER in this draft EIS include these revisions.

25 The NRC staff also made frequent use of the final EIS recently completed as part of the  
26 environmental review for an application submitted by the Tennessee Valley Authority for an  
27 early site permit for a small modular reactor project (the Clinch River Nuclear [CRN] project) on  
28 a site also located within the City of Oak Ridge, situated approximately 2 miles (mi) south of  
29 where Hermes would be built (NRC 2019-TN6136). The CRN and Hermes projects are  
30 separate and unrelated actions, but because of the proximity of the CRN site to the Hermes site  
31 and the recency of the CRN EIS, the staff determined that the CRN EIS contains useful  
32 information about the environmental resources in the Oak Ridge region. The CRN project is  
33 also considered among the other projects proposed in the Oak Ridge region that might  
34 contribute to the cumulative impacts of the Hermes project on environmental resources in the  
35 region. Cumulative impacts are addressed in Section 3.0 of this draft EIS in separate sections  
36 addressing each environmental resource considered.

### 37 1.1 The Proposed Federal Action

38 The proposed action is for the NRC to issue a CP to Kairos authorizing construction of the  
39 Hermes reactor. The site is situated in the Heritage Center Industrial Park of the East  
40 Tennessee Technology Park, an industrial park established by the City of Oak Ridge, on land  
41 formerly owned by the U.S. Department of Energy (DOE) for the Oak Ridge Gaseous Diffusion  
42 Plant (ORGDP). The site was formerly occupied by DOE Buildings K-31 and K-33, which were  
43 both part of the ORGDP (Figure 1-1). DOE ceased operation of the ORGDP in 1986. Both DOE  
44 buildings were since razed, and the land has been environmentally remediated and released for  
45 industrial reuse.

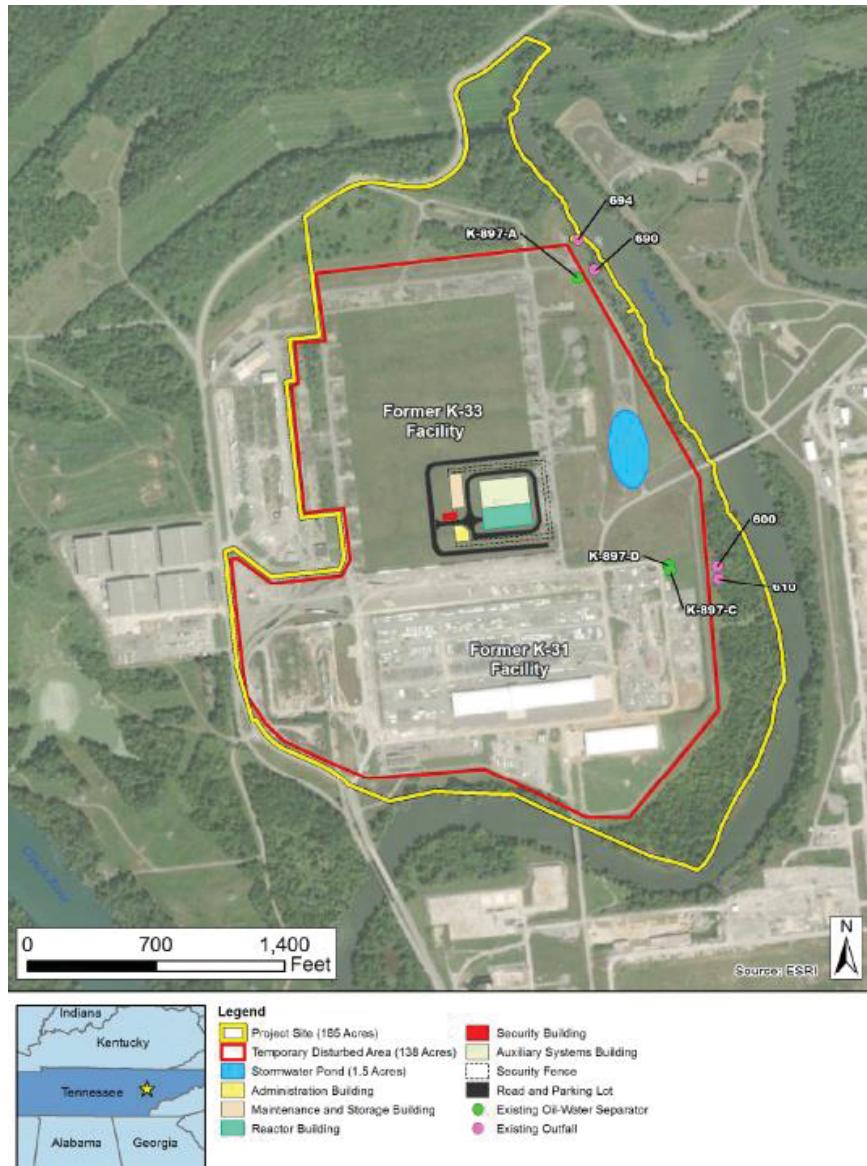


Figure 1-1    Hermes Reactor Site. Source: Kairos 2021-TN7880.

This draft EIS constitutes the NRC staff's review of potential environmental impacts from the proposed action of issuing a CP, as required under 10 CFR 51.70 *et seq.* (TN250). Section 2.0 provides more information about the proposed Hermes project. The issuance of a CP is a separate licensing action from the issuance of an OL. If the NRC issues a CP and Kairos were to seek NRC approval to operate the reactor, then Kairos would have to submit a separate application for an OL pursuant to the NRC's requirements and Kairos would have to obtain NRC approval before it can operate the Hermes testing facility. To conduct a complete environmental review, this draft EIS covers the potential impacts from the construction, operation, and decommissioning life-cycle phases of the Hermes project. The NRC staff recognizes that new and significant information regarding operation and decommissioning may become available subsequent to issuance of the CP. The NRC staff would therefore review any application for an OL for the Hermes project for new and significant information that might alter the staff's

1 conclusions made for this CP application. If Kairos were to apply for an OL, the NRC staff  
2 would prepare a supplement to this EIS in accordance with 10 CFR 51.95(b) (TN250).

3 **1.2 Purpose and Need**

4 Kairos proposes to build and operate the Hermes project to demonstrate key elements of the  
5 Kairos Power Fluoride Salt-Cooled, High Temperature Reactor (KP-FHR) technology for  
6 possible future commercial deployment (Kairos 2021-TN7880 | Sec 1.3). Operation of the  
7 Hermes reactor would not generate any power for sale or distribution. The technology is an  
8 advanced nuclear reactor technology that leverages TRI-structural ISOtropic (TRISO) particle  
9 fuel in pebble form combined with a low-pressure fluoride salt coolant. The Hermes reactor  
10 would support Kairos' reactor development program, which relies on learning and risk reduction  
11 by narrowing the design space through progressive test cycles (Kairos 2021-TN7880 | Sec  
12 1.3). Kairos states that construction and operation of Hermes would also provide validation and  
13 qualification data to support potential future commercial reactors using the KP-FHR technology  
14 (Kairos 2021-TN7880 | Sec 1.3).

15 Kairos participates in DOE's Advanced Reactor Demonstration Program (ARDP), which assists  
16 private industries in the United States in demonstrating advanced nuclear reactors, with the goal  
17 of designing and developing safe and affordable reactor technologies that can be licensed and  
18 deployed over the next 10 to 14 years. Kairos states that the need for the project is tied to  
19 DOE's objectives under the ARDP (Kairos 2021-TN7880 | Sec 1.3).

20 **1.3 The NRC Application Review**

21 The NRC process to review applications for CPs consists of two separate, parallel reviews. The  
22 safety review evaluates the applicant's ability to meet the NRC regulatory safety requirements.  
23 The NRC staff documents the findings of the safety review in a Safety Evaluation Report. The  
24 environmental review, governed by NEPA and the requirements in 10 CFR Part 51 (TN250),  
25 evaluates the environmental impacts of, and alternatives to, the proposed action. This draft EIS  
26 presents the results of this evaluation. The NRC considers the findings in both the EIS and the  
27 Safety Evaluation Report in its decision to grant or deny the issuance of a CP.

28 To guide its assessment of environmental impacts, the NRC staff uses three levels of  
29 significance for potential impacts: SMALL, MODERATE, and LARGE, as defined below:

- 30 • **SMALL** – Environmental effects are not detectable or are so minor that they will neither  
31 destabilize nor noticeably alter any important attribute of the resource.
- 32 • **MODERATE** – Environmental effects are sufficient to alter noticeably, but not to destabilize,  
33 important attributes of the resource.
- 34 • **LARGE** – Environmental effects are clearly noticeable and are sufficient to destabilize  
35 important attributes of the resource.

36 To conduct its environmental review, the NRC staff used guidance contained in the Final Interim  
37 Staff Guidance Augmenting NUREG-1537, Part 1, *Guidelines for Preparing and Reviewing*  
38 *Applications for the Licensing of Non-Power Reactors: Format and Content, for Licensing*  
39 *Radioisotope Production Facilities and Aqueous Homogeneous Reactors*; (NRC 2012-TN5527)  
40 and Part 2, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power*  
41 *Reactors: Standard Review Plan and Acceptance Criteria*, "for Licensing Radioisotope  
42 Production Facilities and Aqueous Homogeneous Reactors (NRC 2012-TN5528). Because the

1 Hermes project is a non-power reactor, the NRC staff considered the guidance developed to  
2 accompany NUREG-1537 to be the best available NRC guidance most applicable to licensing a  
3 test reactor project such as Hermes. As both volumes of the Final Interim Staff Guidance note,  
4 use of the guidance is not mandatory and does not substitute for compliance with NRC  
5 regulations. The NRC staff therefore ensured that its environmental review, as documented in  
6 this draft EIS, met the applicable regulations in 10 CFR Part 51 (TN250) and used the guidance  
7 associated with NUREG-1537 only as supplementary direction.

8 In October 2021, Kairos submitted its ER (Kairos 2021-TN7880) as Part 2 of its two-part CP  
9 application submittal, as discussed above. On November 29, 2021, the NRC notified Kairos of  
10 its decision that the application (including the ER) was sufficient to conduct its detailed review  
11 (NRC 2021-TN7893). The NRC staff published a Notice of Acceptance for Docketing in the  
12 *Federal Register* on December 1, 2021 (86 FR 68290-TN7884) and a separate *Federal Register*  
13 Notice of Intent to prepare an EIS and conduct a scoping process on February 18, 2022 (87 FR  
14 9394-TN7885). Issuance of the scoping notice initiated the 60-day scoping period.

15 On March 23, 2022, the NRC held a virtual joint public outreach and scoping meeting. The  
16 NRC staff also contacted Federal, State, Tribal, regional, and local agencies to solicit  
17 comments. Correspondence between the NRC and Federal, State, Tribal, regional, and local  
18 agencies is included in Appendix C of this draft EIS. The NRC's report entitled, *Environmental*  
19 *Impact Statement Scoping Process Summary Report for the Kairos Hermes Construction Permit*  
20 *Application*, presents the comments received during the scoping process (NRC 2022-TN7953).

21 In March 2022, the NRC staff conducted a virtual audit to verify information in the Kairos ER.  
22 During the audit, the NRC staff reviewed specific documentation and discussed specific  
23 information needs with Kairos staff and their contractors. The information needs and the  
24 pertinent points from that audit are documented in the staff's audit summary report (NRC 2022-  
25 TN7954).

26 This draft EIS presents the NRC staff's analysis that considers and weighs the environmental  
27 impacts of the Hermes project at the proposed site, including the environmental impacts  
28 associated with the construction, operation, and decommissioning of the proposed facilities; the  
29 impacts of constructing, operating, and decommissioning the same facilities at an alternative  
30 site; the no-action alternative; and mitigation measures available for reducing or avoiding  
31 adverse environmental effects. It also provides the NRC staff's preliminary recommendation to  
32 the Commission regarding the issuance of the CP for the proposed Kairos Hermes facility at the  
33 site in Oak Ridge, Tennessee.

34 **1.4 Regulatory Provisions, Permits, and Required Consultations**

35 The applicant has identified each environmental regulatory requirement, permit, and  
36 consultation necessary for construction of the proposed Hermes project in Tables 1.4-1 and  
37 1.4-2 of the ER (Kairos 2021-TN7880 | Sec 1-4). The applicant bears the responsibility for  
38 applying for each of the permits listed in Table 1.4-1 of the ER. The NRC staff bear the  
39 responsibility for performing each of the consultations listed in Table 1.4-2 of the ER required  
40 under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.* TN1010) and  
41 National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101 *et seq.* TN4157).

1    **1.5 Preconstruction Activities**

2    In a final rule dated October 9, 2007 (72 FR 57416-TN260), the Commission established the  
3    definition of “construction” in 10 CFR 51.4 (TN250) as those activities that fall within its  
4    regulatory authority. Many of the activities required to build a test reactor are not part of the  
5    NRC action to license the Hermes facility because they do not have a reasonable nexus with  
6    radiological health and safety and/or common defense and security; therefore, they are not  
7    within the NRC’s authority to regulate. Activities associated with building the proposed facility  
8    that are not within the purview of the NRC action are grouped under the term “preconstruction.”  
9    Under 10 CFR 51.45 (TN250), applicants are required to include in an ER a description of the  
10   impacts of the applicant’s preconstruction activities.

11   Preconstruction activities include clearing and grading, excavating, building of service facilities  
12   (e.g., paved roads, parking lots), erection of support buildings, and other associated activities.  
13   These preconstruction activities may take place before the application for a CP is submitted,  
14   during the staff’s review of a CP application, or after a CP is granted. Consequently, the NRC  
15   evaluates preconstruction impacts as cumulative impacts and not as direct impacts resulting  
16   from the NRC’s Federal action. Although preconstruction activities are outside the NRC’s  
17   regulatory authority, many are within the regulatory authority of local, State, or other Federal  
18   agencies.

19   The applicant could choose to perform preconstruction work before receipt of the requested CP,  
20   or even if the NRC never issues the CP. However, because the preconstruction is a precursor  
21   to NRC-authorized construction of the proposed Kairos Hermes test reactor, and because  
22   discussion of pre-construction and construction impacts together enhances the readability of the  
23   document, Section 3.0 of this draft EIS presents a single combined discussion of  
24   preconstruction and construction impacts for each resource. Because the conclusions  
25   determined by the staff in this EIS for all combined preconstruction and NRC-authorized  
26   construction activity impact category levels are SMALL for all resource areas (e.g., land use,  
27   water resources), no further breakdown of impacts between preconstruction and NRC-  
28   authorized construction is provided.

29   **1.6 Report Contents**

30   The sections of this EIS are organized as follows: Section 1.0 is this introduction. Section 2.0  
31   provides a description of the proposed Hermes project summarizing key elements of the design  
32   needed by the staff to evaluate potential environmental impacts. Most of the information in  
33   Section 2.0 is drawn from the applicant’s description of their project in the ER, PSAR, and other  
34   parts of the application. Section 3.0 describes the affected environment for each of the 12  
35   environmental resources identified by the NRC staff through its scoping process, followed by the  
36   staff’s evaluation of potential environmental impacts on each resource. The staff independently  
37   verified and summarized the affected environment descriptions from the ER and other public  
38   documents, relying on incorporation by reference to the extent possible to simplify the EIS. The  
39   staff developed their evaluations of environmental impacts independently from the applicant, but  
40   the staff relied in part on impact data presented by the applicant after independent verification.  
41   Section 4.0 of this draft EIS presents the staff’s evaluation of a range of reasonable alternatives  
42   to the proposed action. Section 5.0 summarizes the staff’s conclusions and recommendation to  
43   the NRC Commission based on the environmental review.

44   The appendices to this draft EIS contain the following additional information:

- 1 Appendix A – Contributors to the Environmental Impact Statement
- 2 Appendix B – Agencies, Organizations, and Individuals Contacted
- 3 Appendix C – Chronology of Key Environmental Review Correspondence
- 4 Appendix D – Regulatory Compliance and List of Federal, State, and Local Permits and
- 5 Approvals
- 6 Appendix E – Greenhouse Gas Emissions
- 7 Appendix F – Viewshed Photographs at Nearby Historic and Cultural Resources.

## 1           2.0 PROPOSED PROJECT

2       The proposed Federal action is for the U.S. Nuclear Regulatory Commission (NRC) to issue a  
3       construction permit (CP) to Kairos Power, LLC (Kairos) under Title 10 of the *Code of Federal*  
4       *Regulations* Part 50 (TN249) to construct the proposed Kairos Hermes non-power  
5       demonstration reactor in Oak Ridge, Tennessee. After receipt of a CP from the NRC, the  
6       applicant is required to apply for a separate operating license (OL) under 10 CFR Part 50  
7       (TN249) before reactor operation and prior to initiating decommissioning activities. The NRC  
8       would perform separate environmental reviews for the OL application and for subsequent  
9       licensing actions, such as OL renewal and decommissioning. The information presented below  
10      summarizes key characteristics of the Hermes project that the NRC staff considered when  
11      assessing the environmental impacts of the proposed action. The summaries focus on  
12      construction of the proposed facilities but also include general information about operation and  
13      decommissioning of the facilities to the extent currently known. Any new and significant  
14      information not addressed in the environmental review for the CP would be addressed as  
15      necessary in any subsequent environmental reviews for an OL application or for  
16      decommissioning.

### 17      2.1 **Project Overview**

18     The Hermes project would test and demonstrate key technologies, design features, and safety  
19     functions of the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor (KP-FHR)  
20     technology; and it would provide data that may be used for validation of safety analysis tools  
21     and computational methodologies used for designing and licensing future reactors using the  
22     technology (Kairos 2021-TN7880 | Sec 2.1). Kairos plans to begin construction as early as  
23     April 2023 (Kairos 2021-TN7880 | Sec 2.1) with an operational life of 4 years (Kairos 2022-  
24     TN7881). The NRC staff recognizes that the applicant's estimated dates for construction,  
25     operation, and decommissioning are approximate and that the actual dates might differ.  
26     Information related to land disturbance, onsite workers, and material usage is provided in  
27     Chapter 2 of the environmental report (ER) and summarized in the sections below.

28     The proposed Kairos Hermes non-power demonstration reactor would demonstrate an  
29     advanced nuclear reactor technology that leverages TRI-structural ISOtropic (TRISO) particle  
30     fuel in pebble form with a low-pressure fluoride salt coolant (Kairos 2021-TN7880 | Sec 1.3).  
31     The proposed facilities would house one Hermes reactor, as described in Section 2.3 of the ER,  
32     as supplemented (Kairos 2021-TN7880, Kairos 2022-TN7881, Kairos 2022-TN7882, and Kairos  
33     2022-TN7883). A process flow diagram for the Hermes reactor is presented in Figure 2.3-1 of  
34     the ER, as supplemented (Kairos 2021-TN7880, Kairos 2022-TN7881, Kairos 2022-TN7882,  
35     and Kairos 2022-TN7883). The core configuration would consist of a pebble bed core, graphite  
36     moderator/reflector, and a lithium tetrafluoroberyllate ( $\text{Li}_2\text{BeF}_4$ , Flibe) molten salt coolant (Kairos  
37     2021-TN7880 | Sec 2.3). Flibe has several important properties for use in a nuclear reactor,  
38     such as neutronic factors and stability at high temperatures. Additional information about Flibe  
39     is provided in Chapter 2 of the Kairos Topical Report Reactor Coolant for the Kairos Power  
40     Fluoride Salt-Cooled High Temperature Reactor", KP-TR-005-NP (Kairos 2020-TN7988 | Sec  
41     2.1). The facilities would contain one unit with a maximum thermal power of 35 megawatts  
42     (MW) (Kairos 2021-TN7880 | Sec 2.3). Because Hermes would be a research and  
43     demonstration reactor, the heat generated would not be used to generate electric power.  
44     Instead, the heat would be transported out of the core by a primary heat transport system and  
45     dissipated to the atmosphere by a heat rejection radiator (Kairos 2022-TN7882). The reactor  
46     core would be fueled using graphite pebbles with a diameter of 4 centimeter (cm) with

1 embedded coated TRISO particle fuel (Kairos 2021-TN7880 | Sec 2.3). The particles would  
2 comprise a uranium fuel kernel and three layers of carbon and ceramic-based materials that  
3 prevent the release of radioactive fission products (Kairos 2021-TN7880 | Sec 2.3). The  
4 maximum enrichment of the uranium would be up to 19.55 wt% (Kairos 2021-TN7880 | Sec  
5 2.3).

6 **2.2 Site Location and Layout**

7 The applicant describes the site location and layout in Section 2.2 of the ER (Kairos 2021-  
8 TN7880). Kairos is proposing the new facilities to be built at a 185 ac site in the East  
9 Tennessee Technology Park. As depicted in Figure 2.2-1 of the ER (Kairos 2021-TN7880),  
10 construction would involve approximately 135 acres (ac) of land on the site that had previously  
11 been occupied by Buildings K-31 and K-33, which were formerly part of the U.S. Department of  
12 Energy (DOE) Oak Ridge Gaseous Diffusion Plant complex on the Oak Ridge Reservation  
13 (ORR). The new facilities would occupy approximately 30 ac within the former footprint of the  
14 K-33 facility. Figure 2.2-3 of the ER (Kairos 2021-TN7880) depicts the proposed layout of the  
15 new facilities, which would include a reactor building, auxiliary systems building, maintenance  
16 and storage building, administration building, security building, security fence, and roads and  
17 parking lots. Use of the site would take advantage of existing roads and other utilities within the  
18 Heritage Center Industrial Park of the East Tennessee Technology Park, and no land outside of  
19 the indicated 135 ac would be disturbed to build, operate, or decommission the new facilities.  
20 The only new roads and parking lots that would need to be constructed would be built within the  
21 30 ac tract to directly service the new buildings. The Hermes project would not involve building  
22 or operating transmission lines, switchyards, intake or discharge structures or pipelines, access  
23 roads, heavy haul roads, rail lines or spurs, barge facilities, heavy haul roads, batch plants, or  
24 other offsite facilities.

25 **2.3 Site Workers and Vehicular Deliveries**

26 The applicant estimates the numbers of site workers and vehicular deliveries in Section 2.1 of  
27 the ER (Kairos 2021-TN7880). The applicant estimates that construction would require an  
28 estimated average of 212 onsite workers, with 425 at peak times, and would involve a monthly  
29 average of 213 truck deliveries and four-offsite shipments of construction debris. Operation is  
30 estimated to involve an average of 38 workers per weekday (68 full-time positions), with an  
31 estimated monthly average of 15 truck deliveries and four-offsite waste shipments. The  
32 applicant estimates that decommissioning would require an average of 170 workers (340  
33 workers at peak times) and a monthly average of four-truck deliveries and 170 offsite waste  
34 shipments (Kairos 2021-TN7880 | Sec 2.1).

35 **2.4 Equipment and Material Usage**

36 The applicant provides estimates of anticipated equipment and material use by the project in  
37 Section 2.1 of the ER, as supplemented (Kairos 2021-TN7880, Kairos 2022-TN7882). Table  
38 2.1-1 in the ER (Kairos 2021-TN7880) provides the applicant's estimates of material such as  
39 concrete and steel that would be consumed during construction. Table 2.1-2 in the ER (Kairos  
40 2021-TN7880) presents a list of equipment that the applicant proposes to use during the  
41 construction and decommissioning phases. The applicant also provides estimates of  
42 anticipated shipments of coolants and other process chemicals, diesel fuel for the standby  
43 diesel generator, and other materials. Hazardous materials stored onsite during operation  
44 include Flibe, lubricating oil, and cleaning materials and consumables used for cleaning and

1 maintenance. As much as 21,555 gallons (gal) of diesel fuel for the standby diesel generator  
2 would be stored in an onsite storage tank.

3 **2.5 Water Consumption and Treatment**

4 A detailed description of how the applicant would obtain, use, and discharge water is provided in  
5 Section 2.4 of the ER (Kairos 2021-TN7880). The applicant's proposed water balance diagram  
6 for the new facilities is depicted in Figure 2.4-1 of the ER (Kairos 2021-TN7880). Water  
7 demands during construction, operation, and decommissioning of the proposed facilities would  
8 be met using municipal sources or truck deliveries; and wastewater generated by the operation  
9 of the proposed facilities would be discharged into municipal sewers that service the East  
10 Tennessee Technology Park. The project would not involve the use of any raw surface water or  
11 groundwater and, therefore, would not involve building or operation of intake or discharge  
12 pipelines. The project would not involve any reservoirs, evaporation ponds, leach fields, or  
13 similar facilities. Temporary dewatering of the reactor excavation pit during construction may be  
14 necessary but would be managed in accordance with DOE, U.S. Environmental Protection  
15 Agency, and Tennessee Department of Environment and Conservation requirements and in  
16 conformance with deed restrictions (Kairos 2021-TN7880 | Sec 4.4.1.1.1). As shown in the  
17 water balance diagram in Figure 2.4-1 of the ER, the operational demand for offsite water  
18 sources would include 50 gallons per minute (gpm) of municipal water plus 12 truck shipments  
19 of 4,000 gal each of demineralized water per month, and the offsite discharges would include  
20 16 gpm from the bathrooms and 1 gpm from the decay heat removal system (DHRS). This  
21 municipal supply water would be used for potable water and sanitation, the fire protection  
22 system, decay heat removal, systems cooling components and spent fuel, and other operational  
23 demands.

24 **2.6 Cooling and Heat Removal Systems**

25 The proposed cooling and heating systems are described in Section 2.5 of the ER, as  
26 supplemented (Kairos 2021-TN7880, Kairos 2022-TN7882). As noted in Section 2.5.1 of the  
27 ER, there would be no cooling water system. For this reason, there would be no need for  
28 cooling towers or for intake or discharge structures or piping to support cooling towers. The  
29 heat load from the reactor would be transferred through a heat rejection system directly to the  
30 surrounding atmosphere, which would be the ultimate heat sink. The design also contains a  
31 DHRS, as described in Section 2.5.2 of the ER with diagrammatic representation in ER Figure  
32 2.5-1 (Kairos 2021-TN7880). If the heat rejection system were unavailable when residual heat  
33 removal is required, the DHRS would be used instead (Kairos 2022-TN7882). The applicant  
34 expects to build the heat rejection radiator stack in the auxiliary systems building just north of  
35 the reactor building (see Figure 2.2-3 of the ER for the estimated positions of these buildings on  
36 the site) (Kairos 2022-TN7882).

37 **2.7 Waste Systems**

38 Wastes generated during construction, operation, and decommissioning would include  
39 radioactive, nonradioactive, and hazardous wastes (Kairos 2021-TN7880 | Sec 2.6). The  
40 applicant indicates that all waste disposal would occur in permitted nonradioactive,  
41 nonhazardous, and hazardous waste facilities and licensed radioactive disposal facilities (Kairos  
42 2021-TN7880 | Sec 2.6). The proposed radioactive liquid, solid, and gaseous waste systems  
43 are described in Section 2.6.1 of the ER, as supplemented (Kairos 2021-TN7880, Kairos 2022-  
44 TN7882). Included in the ER are descriptions of the tritium management system and fuel

1 pebble handling and storage system. Figure 2.6-1 of the ER depicts the approximate  
2 distribution of tritium throughout the reactor system (Kairos 2021-TN7880).

3 The estimated types, quantities, and number of shipments of radioactive wastes are listed in  
4 Table 2.6-1 of the ER, as supplemented (Kairos 2021-TN7880, Kairos 2022-TN7882), and  
5 include inert gas system capture materials, reactor cell capture materials, Flibe, dry active  
6 waste, liquid waste, and spent fuel. The table also identifies possible destinations for each  
7 category of waste. The proposed nonradioactive and hazardous waste systems are described  
8 in Section 2.6.1 of the ER (Kairos 2021-TN7880). Direct radiation sources are described in  
9 Section 2.6.3.1 of the ER and would all be within the reactor building (Kairos 2021-TN7880).  
10 The applicant notes that ongoing operation of ORR facilities and of the existing Tennessee  
11 Valley Authority Watts Bar Nuclear Facility would also contribute to the radiation dose received  
12 by the public near the new facilities (Kairos 2021-TN7880 | ER Sec 2.6.3). The applicant's  
13 proposed pollution prevention and waste minimization program is described in Section 2.6.4 of  
14 the ER (Kairos 2021-TN7880).

## 15 **2.8 Storage, Treatment, and Transportation of Radioactive and Nonradioactive** 16 **Materials**

17 The applicant describes the proposed storage, treatment, and transportation of radioactive and  
18 nonradioactive materials in Section 2.7 of the ER, as supplemented (Kairos 2021-TN7880,  
19 Kairos 2022-TN7881). Used, or spent, TRISO fuel pebbles would be stored in canisters, each  
20 holding up to 2,100 pebbles, in the reactor building; first in an onsite water-cooled storage pool  
21 for an initial cooling period and then transferred to a larger onsite air-cooled storage cavity with  
22 a storage capacity of 192 canisters, sufficient for the anticipated period of operation (Kairos  
23 2021-TN7880 | Sec 2.7.1). If necessary, Kairos could store the spent TRISO fuel canisters in  
24 dry storage casks at an exterior location on the site after the cessation of operation (Kairos  
25 2021-TN7880 | Sec 2.7.1). Spent fuel would eventually be transported by truck or rail to a final  
26 spent fuel repository or a regional spent fuel storage facility (Kairos 2021-TN7880 | Sec 2.7.1).  
27 Handling of low-level radioactive waste and nonradioactive materials is described in Sections  
28 2.7.2 and 2.7.3, respectively, of the ER (Kairos 2021-TN7880).

## 1      3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

2      This section presents the affected environment and potential environmental impacts from the  
3      proposed action to issue a construction permit (CP) for the Kairos Power, LLC (Kairos) Hermes  
4      facilities. The section is organized into separate sections addressing specific environmental  
5      resources identified by the U.S. Nuclear Regulatory Commission (NRC) staff's scoping process  
6      as being relevant to the proposed action. Each section is organized into subsections addressing  
7      the affected environment for the resource; potential direct and indirect impacts on the resource  
8      from each of three life-cycle phases for the Hermes facilities (construction, operation, and  
9      decommissioning); and cumulative impacts from the facilities. Each section culminates in a final  
10     subsection presenting the NRC staff's conclusions regarding the significance of the  
11     environmental impacts. Certain sections addressing two substantially independent though  
12     interrelated environmental resources, e.g., air quality and noise, are divided into two subsections  
13     organized as indicated above and lead to separate conclusions. The range of possible  
14     conclusions used by the NRC staff in assessing the significance of impacts on environmental  
15     resources is presented in Section 1.0 of this environmental impact statement (EIS).

16     To present a complete environmental review, this draft EIS covers the potential impacts from  
17     the construction, operation, and decommissioning life-cycle phases of the Hermes project. The  
18     NRC staff recognizes that new and significant information regarding the operation and  
19     decommissioning may become available after issuance of the CP. The NRC staff would  
20     therefore review any application for an operating license (OL) for the Hermes project for new  
21     and significant information that might alter the staff's conclusions made for this CP application.  
22     If Kairos were to apply for an OL, the NRC staff would prepare a supplement to this EIS in  
23     accordance with Title 10 of the *Code of Federal Regulations* 10 CFR 51.95(b) (TN250).

24     The order of presentation of environmental resources follows that used in Section 19.4 of the  
25     Final Interim Staff Guidance Augmenting NUREG-1537 (NRC 2012-TN5527), with the following  
26     exceptions. First, the NRC staff considered it more efficient to combine the sections about  
27     geological environment and water resources into a single Hydrogeology and Water Resources  
28     section (Section 3.3). Although the staff presents separate analyses and conclusions regarding  
29     impacts on the geological environment and on water resources, the combined subsection  
30     emphasizes their interrelationship. Second, the staff presented the environmental justice (EJ)  
31     analysis as part of the socioeconomic analysis in Section 3.6. The staff considered it simpler to  
32     present the EJ analysis with the supporting socioeconomic information rather than forcing  
33     readers to toggle between separate sections to gain an understanding. Third, the staff  
34     developed two separate sections addressing nonradiological and radiological waste  
35     management, but not nonradiological waste. The staff termed the latter "Uranium Fuel Cycle  
36     and Radiological Waste Management" to also capture uranium fuel cycle impacts.

37     Finally, the staff considered it more efficient to address cumulative impacts within the sections  
38     addressing other impacts to each resource rather than in a separate section as called for in the  
39     Final Interim Staff Guidance (NRC 2012-TN5527). Cumulative impacts are defined as impacts  
40     on an environmental resource resulting from the incremental impact of the action when added to  
41     other past, present, and reasonably foreseeable future actions regardless of which Federal or  
42     non-Federal agency or private party undertakes the other actions (40 CFR 1508.1(g)(3)  
43     [TN428]). Cumulative impacts can result from individually minor but collectively significant  
44     actions taking place over time (40 CFR 1508.1(g)(3) [TN428]).

1 The applicant presents a list of past, present, and reasonably foreseeable projects and other  
2 actions used in their consideration of cumulative impacts in the Environmental Report (ER)  
3 Table 4.13-1 (Kairos 2021-TN7880 | Table 4.13-1). The continued U.S. Department of Energy  
4 (DOE) operations connected with the Oak Ridge National Laboratory (ORNL) and the Y-12 site;  
5 industrial development in the East Tennessee Technology Park, including the Heritage Center  
6 Industrial Park (Heritage Center) (within which the Hermes site is situated) and the Horizon  
7 Center Industrial Park (Horizon Center) to the east; and development of a general aviation  
8 airport to the south are included in the table. Additional actions included are the continued  
9 operation of the Sequoyah Nuclear Plant (Sequoyah) and Watts Bar Nuclear Plant (Watts Bar)  
10 and future construction and operation of small modular reactors at the Clinch River Nuclear  
11 (CRN) site approximately 2 miles (mi) south of the Hermes site. The NRC staff reviewed that  
12 table and concluded that it is an appropriate range of other actions for consideration in its  
13 cumulative impact assessment and incorporates it by reference. Table 4.13-1 in the ER notes  
14 that the applicant plans to build and operate a fuel fabrication facility, termed the Kairos Atlas  
15 Fuel Fabrication Facility (Atlas facility), at the Hermes site. Additionally, another energy  
16 development company, TRISO-X LLC, has recently announced that they plan to build and  
17 operate a TRISO-X fuel fabrication facility on an unused 110 ac lot in the Horizon Center east of  
18 the Heritage Center where the Hermes site is located (TRISO-X, LLC. 2022-TN7987). The staff  
19 also expects that continued general urbanization in and around the City of Oak Ridge would  
20 contribute to the cumulative impacts.

21 The NRC staff recognizes that only a subset of this master list of other actions is relevant to  
22 cumulative impact analysis for each environmental resource addressed. The subsections under  
23 each resource addressing cumulative impacts highlight those specific actions from ER Table  
24 4.13-1 that are most relevant to an analysis of cumulative impacts for that resource. As  
25 explained in Section 1.0, some activities necessary to build a nuclear project such as Hermes  
26 do not fall within the purview of NRC's regulatory jurisdiction over construction as defined in  
27 10 CFR 50.10 (TN249) and 10 CFR 51.4 (TN250) and are grouped under the term  
28 "preconstruction." The NRC staff does not consider the effects of preconstruction to be direct or  
29 indirect impacts on a licensing action, but it does recognize the need for evaluating the  
30 contribution of preconstruction to cumulative impacts. Identifying the impacts of preconstruction  
31 is also necessary to understand the setting for impacts from NRC-authorized construction  
32 activities, as well as impacts from subsequent life-cycle phases. For example, clearing portions  
33 of a site before beginning a project is preconstruction, but knowing the extent of the clearing is  
34 necessary to know what nearby ecological habitats might be affected by noise generated by  
35 subsequent regulated activities. The sections below therefore describe impacts from  
36 preconstruction and construction jointly for each resource. The joint description, when  
37 combined with information on impacts from operation and decommissioning and from other  
38 projects in the area, provides a complete basis for drawing conclusions regarding direct,  
39 indirect, and cumulative impacts.

## 40 **3.1 Land Use and Visual Resources**

### 41 **3.1.1 Affected Environment**

42 As described in Section 3.1.1 of the ER (Kairos 2021-TN7880), the site consists of  
43 approximately 185 acres (ac) situated in the Heritage Center in the East Tennessee Technology  
44 Park within the corporate limits of the City of Oak Ridge, Tennessee. The site is in Roane  
45 County, approximately 13 mi west of the densely developed downtown area of Oak Ridge. The  
46 site was previously part of the DOE Oak Ridge Reservation (ORR). The site formerly  
47 accommodated Buildings K-31 and K-33, two large rectangular industrial buildings that were

1 operated until 1985 by DOE as part of the Oak Ridge Gaseous Diffusion Plant (ORGDP) (Kairos  
2 2021-TN78800 | Sec 1.2). Table 3.1-1 (Kairos 2021-TN7880) of the ER quantifies the current  
3 land uses on the site and in the region, and Figure 3.1-1 of the ER (Kairos 2021-TN7880)  
4 depicts the current land uses graphically. Land cover on the site at present consists of  
5 approximately 72 ac of herbaceous grassland, mostly where Building K-33 formerly stood;  
6 approximately 87 ac of developed (medium and high intensity) land, mostly where Building K-31  
7 formerly stood, that is currently being used for temporary outdoor industrial purposes; and  
8 approximately 24 ac of deciduous and mixed forest cover and woody (dominated by trees and  
9 shrubs) wetlands along the site's southern and eastern perimeters.

10 Figure 3.1-3 of the ER (Kairos 2021-TN7880) shows that the site is in the northwestern part of  
11 the previously developed ORGDP land. DOE completed the core cleanup of the former  
12 ORGDP lands in 2020 and privatized ownership of 1,300 ac, including the site; and DOE  
13 expects to complete the ORGDP cleanup by 2024 and privatize an additional 600 ac (DOE  
14 2022-TN7897). DOE decontaminated Buildings K-31 and K-33 between 1998 and 2005 and  
15 razed the structures and removed their slabs between 2011 and 2015 (Kairos 2021-TN7880 |  
16 ER Sec 3.5.3). The site is zoned by the City of Oak Ridge as IND-2 (Industrial Districts IND-2)  
17 (City of Oak Ridge 2021-TN7900), a general industrial district established to provide areas in  
18 which the principal use of land is for processing, manufacturing, assembling, fabrication, and  
19 warehousing (City of Oak Ridge 2020-TN7901).

20 The "region" of the site is defined as the area within a 5 mi radius of the site center point. The  
21 region comprises a mixture of urban and rural uses characterized in Section 3.1.1.2 of the ER  
22 (Kairos 2021-TN7880 | ER Sec 3.1.1.2) and depicted in Figure 3.1-2 of the ER (Kairos 2021-  
23 TN7880). Section 3.1.1.2 of the ER (Kairos 2021-TN7880) provides information about  
24 navigable waterways, highways and roads, rail lines, natural gas pipelines, and airports in the  
25 region. Although the region includes agricultural land, there is no economically significant crop  
26 production. There are no chemical plants, refineries, mining or quarrying, or military facilities  
27 within 5 mi of the site.

28 The visual setting of the site is described in Section 3.1.2 of the ER (Kairos 2021-TN7880). It is  
29 influenced by a predominantly industrial setting to the south and east, where the currently and  
30 formerly developed areas of the Heritage Center and other East Tennessee Technology Park  
31 lands are situated; and a predominantly forested setting to the north, consisting of the forested  
32 lands on the 3,073 ac Black Oak Ridge Conservation Easement. The applicant characterizes  
33 the scenic quality of the site with the lowest available rating (that of C), using a subjective rating  
34 process developed by the Bureau of Land Management (BLM 1984-TN5536). Scenic quality is  
35 the relative worth of a landscape from a visual perception point of view. The C rating reflects  
36 the existing modifications of the site and surrounding industrial areas (Kairos 2021-TN7880 |  
37 Sec 3.1.2). The applicant subjectively characterizes the site's sensitivity level, a measure of  
38 public concern for the maintenance of scenic quality, as "low to moderate" (Kairos 2021-TN7880  
39 | Sec 3.1.2). The sensitivity level considers the types of users, amount of use, public interest,  
40 adjacent land users, and special area management objectives. The NRC staff finds the  
41 applicant's subjective determinations to be reasonable in that they reflect the large areas of  
42 previously disturbed and graded soils on and close to the site, ongoing industrial redevelopment  
43 of the surrounding landscape, and broad areas of forest cover separating the industrial area  
44 from the closest residential land uses.

1    **3.1.2    Environmental Impacts of Construction**

2    Figure 2.2-1 of the ER indicates that construction would temporarily disturb approximately  
3    138 ac of previously developed industrial lands on the site, but that the disturbance would not  
4    encroach into areas of natural vegetation (Kairos 2021-TN7880). Based on projected start  
5    dates reported in Section 2.1 of the ER (Kairos 2021-TN7880), temporary land uses would likely  
6    persist for two to three-years. Once built, the new facilities would permanently occupy  
7    approximately 30 ac of land within the footprint of the former K-33 facility (and within the area  
8    already subject to temporary disturbance). The City of Oak Ridge informed the applicant that  
9    because the proposed Hermes reactor is not designed to generate power, it fits within the range  
10   of activities allowed under the IND-2 zoning (Kairos 2022-TN7902). Had the reactor been  
11   designed to generate power, it may have required IND-3 zoning. Unlike the IND-2 zoning,  
12   IND-3 zoning specifically allows for power generation facilities (City of Oak Ridge 2020-  
13   TN7901). The DOE completed an environmental assessment (EA) in 2011 for the transfer of up  
14   to approximately 1,800 ac of East Tennessee Technology Park land including what is now the  
15   proposed Hermes site (DOE 2011-TN4888). DOE concluded that the anticipated industrial and  
16   commercial development would not significantly change the existing industrial land use  
17   character and appearance of the already highly disturbed main portion of the East Tennessee  
18   Technology Park, which includes what is now the proposed Hermes site (DOE 2011-TN4888  
19   | Sec 3.1.2.1). DOE notes that the anticipated future land use scenarios in the transferred lands  
20   include (among other uses) research and testing facilities, including renewable and advanced  
21   energy, industrial, and scientific research laboratories that include incidental pilot plant  
22   processing operation (DOE 2011-TN4888 | Sec 2.1.1).

23   Building the Hermes facilities would disturb only lands whose soils were previously graded to  
24   build the former K-31 and K-33 facilities; therefore, the project has no potential to disturb natural  
25   soils potentially capable of meeting the definitions of prime or unique farmland or other special  
26   status farmland. Because there is no agricultural activity on or adjacent to the site, and only  
27   small-scale agricultural production in the region (Kairos 2021-TN7880 | Sec 3.1.1), there is little  
28   potential for noticeable impacts on agricultural land uses. Land disturbance would not encroach  
29   into any wetlands (Kairos 2021-TN7880 | Sec 4.5.1.2). Disturbances would be limited to areas  
30   mapped by the Federal Emergency Management Agency as "Zone X" (Kairos 2021-TN7880 |  
31   Figure 3.4-2) and would not encroach into 100-year or 500-year floodplain lands (Kairos 2021-  
32   TN7880 | Sec 3.4.1.1.7). The proposed project would not extend to the Oak Ridge Wildlife  
33   Management Area, Black Oak Ridge Conservation Easement, or other special land uses in the  
34   region (Kairos 2021-TN7880 | Sec 4.1.1.2), although it might be distantly visible from parts of  
35   those areas. As discussed in Section 3.5 on historic and cultural resources, the proposed  
36   project would be visible from, but would not substantially interfere with, the public's use and  
37   enjoyment of nearby Manhattan Project National Historical Park (NHP).

38   The project would introduce new industrial facilities only into an established industrial setting  
39   and would not qualitatively alter the visual character of the setting or surrounding region. The  
40   tallest structures built on the site would be ventilation stacks with a height of 100 feet (ft) (Kairos  
41   2021-TN7880 | Sec 4.1.2). The applicant presents a visual simulation of the proposed facilities  
42   in Figure 4.1-1 of the ER (Kairos 2021-TN7880) as well as three-dimensional computer-  
43   generated renderings overlaying the proposed facilities on ground-level photographs from six  
44   key observation points at visually sensitive locations surrounding the site (Kairos 2021-TN7880  
45   | Figure 4.1-2). The selected observation points include locations in a new residential  
46   development approximately 2 miles to the west of the site, other nearby residential areas, a  
47   parking area and trailhead for the Black Oak Ridge Conservation Easement north of the  
48   Heritage Center and rest of the East Tennessee Technology Park, a historic cemetery

1 approximately 1 mi to the south, and the K-25 Overlook and Visitor Center approximately 1 mi to  
2 the southwest. The computer renderings (Kairos 2021-TN7880 | Figures 4.1-3 through 4.1-8)  
3 demonstrate that the view of the new facilities from the observation points would be blocked by  
4 existing vegetation (Kairos 2021-TN7880 | Sec 4.1.2). The applicant acknowledges that the  
5 facilities might be visible in the far distance when the deciduous trees are leafless but suggests  
6 that the surrounding hills and mountains would soften the industrial appearance of the facilities  
7 (Kairos 2021-TN7880 | Sec 4.1.2). Considering the existing industrial character of the East  
8 Tennessee Technology Park, the visual changes from construction would not be noticeable.

9 **3.1.3 Environmental Impacts of Operation**

10 The completed facilities would occupy approximately 30 ac within the footprint of the former  
11 Building K-33, as indicated above, for a four-year operational period. The applicant has  
12 identified the entire 185 ac site as the exclusion area for the Hermes reactor (Kairos 2021-  
13 TN7879 | Figure 2.1-3). Under 10 CFR 100.3 (TN282), "Definitions," the exclusion area is an  
14 area surrounding a reactor, that must meet specific radiological criteria outlined in 10 CFR  
15 100.11 (TN282), "Determination of exclusion area, low population zone (LPZ), and population  
16 center distance," in which the reactor licensee has the authority to determine all activities  
17 including exclusion or removal of personnel and property. The remaining 108 ac within the area  
18 of temporary disturbance would be available for other land uses under Kairos' control once they  
19 are no longer needed for construction. No additional land would be disturbed for the Hermes  
20 project during operation. Operational activity would be consistent with the site's zoning and  
21 industrial setting. The overall appearance of the Hermes facilities would not noticeably change  
22 during the operational period. The NRC staff therefore expects that the land use and visual  
23 impacts from operation would be minimal.

24 **3.1.4 Environmental Impacts of Decommissioning**

25 Land-disturbing activities during decommissioning would generally resemble those during  
26 construction and involve the use of heavy equipment to remove buildings, roadways, and other  
27 structures (Kairos 2021-TN7880 | Sec 4.1.1.5). Although most work would take place within  
28 the approximately 30 ac of land occupied by the formerly operational facilities, the staff expects  
29 that some adjoining land within the lands temporarily disturbed for construction might be  
30 temporarily required for laydown of equipment and materials. Decommissioning could ultimately  
31 free up all or part of the site for other uses consistent with the objectives of the Heritage Center.  
32 The overall visual appearance of the site would remain industrial throughout decommissioning,  
33 but the site could then revert to a vacant appearance until the site is ultimately redeveloped.  
34 The decommissioning impacts on land use and visual resources would be bounded by the  
35 analyses in the decommissioning generic EIS (NRC 2002-TN7254). Although the conclusions  
36 of the generic EIS extend only to the site and not surrounding lands, the land use impacts for  
37 decommissioning Hermes would not involve use of surrounding land. The NRC staff therefore  
38 expects that the land use and visual impacts from decommissioning would be minimal.

39 **3.1.5 Cumulative Impacts**

40 Tables 4.13-1 and 4.13-2 of the ER identify past, present, and reasonably foreseeable future  
41 projects that could cumulatively contribute to the environmental impacts of the proposed action  
42 (Kairos 2021-TN7880). Key past and present actions affecting land resources and visual quality  
43 in the affected area include the Federal nuclear and energy development facilities on the ORR  
44 such as the Y-12 plant, ORNL, and other energy research facilities; the residential and  
45 commercial areas in the original townsite of the City of Oak Ridge; multiple energy and industrial

1 park projects; a large housing development currently undergoing construction approximately  
2 2 mi west of the site termed the Preserve at Clinch River; and other land use features of a  
3 suburban or semi-rural landscape. Key reasonably foreseeable proposed projects in the region  
4 include the Horizon Center on former ORR forest land approximately 2.3 mi northeast of the site  
5 (for which DOE has excessed land to the City of Oak Ridge and roadways have been built),  
6 anticipated industrial development of other previously developed land in the Heritage Center,  
7 and a proposed general aviation airport approximately 1.1 mi south and east of the site.  
8 Additionally, as noted above in Section 3.0, the applicant anticipates possibly using a portion of  
9 the site outside of the Hermes facilities to build and operate the Atlas fuel fabrication facility.  
10 Another company (TRISO-X, LLC. 2022-TN7987) has recently announced that they plan to  
11 build and operate a TRISO-X fuel fabrication facility on an unused 110 ac lot in the Horizon  
12 Center to the east.

13 The NRC staff expects that the ongoing and reasonably foreseeable projects noted above and  
14 other anticipated continued development around Oak Ridge would increase the extent of  
15 industrial and other urban land in the region but would not noticeably change its land use  
16 patterns or overall visual quality. The City and DOE have planned over several decades to  
17 attract industrial development to the East Tennessee Technology Park to offset losses of  
18 employment from closure of the ORGDP and winding down environmental cleanup. Substantial  
19 infrastructure such as roads and utilities are already in place for the East Tennessee  
20 Technology Park, including the Heritage Center and Horizon Center, although the character of  
21 specific projects that ultimately use East Tennessee Technology Park land could necessitate  
22 additional infrastructure development. The infrastructure would, however, be built in areas that  
23 already display an industrial character and visual appearance.

24 The reasonably foreseeable new projects that have the greatest potential to affect land uses  
25 and visual qualities in the area around the site are the proposed Atlas facility and the proposed  
26 general aviation airport. The proposed Atlas facility would be built somewhere on the same  
27 185 ac site proposed for the Hermes project. The applicant has indicated that the Atlas facility  
28 would occupy no more than 30 ac on the site (Kairos 2022-TN7902), located outside of the  
29 approximately 30 ac of land occupied by the Hermes facilities during operation but still within the  
30 proposed reactor's exclusion area, which encompasses the remainder of the site. According to  
31 the NRC definition of the exclusion area in 10 CFR 100.3 (TN282), activities unrelated to  
32 operation of the reactor may be allowed in an exclusion area under appropriate limitations,  
33 provided that no significant hazards to public health and safety would result. Because the Atlas  
34 facility would be built by the same applicant as the Hermes facilities, the NRC staff expects that  
35 the applicant would design the Atlas facility to be compatible with respect to land use with the  
36 Hermes project. Building the Atlas facility would not substantially alter the already industrial  
37 character and appearance of the Hermes site and the Heritage Center overall. The NRC staff  
38 would ensure the compatibility of the Atlas facility with the land uses and visual quality of the  
39 Hermes site and the Heritage Center in general when reviewing a future licensing application for  
40 the Atlas facility project.

41 Building the airport would require dedication of hundreds of acres of land within the East  
42 Tennessee Technology Park but would enhance rather than conflict with the City's efforts to  
43 attract employers to the Heritage Center and other former DOE lands targeted for  
44 redevelopment. It would not substantially alter the industrial appearance and visual quality of  
45 the Heritage Center. Operating an airport requires limiting nearby land uses as necessary to  
46 keep the approach and departure zones at the ends of the runways free of obstructions to  
47 aircraft. The new airport would however be situated more than 1 mi south of the Hermes site  
48 and would be oriented such that the approach and departure zones would extend east and west

1 of the runway, not north (DOE 2016-TN7903). The applicant indicated that the tallest structure  
2 height of the proposed Hermes facilities would be less than 200 ft and therefore would not meet  
3 the definition of a flight obstruction, as established by the Federal Aviation Administration in  
4 14 CFR 77.17 (a) (TN7902). The applicant indicated that it would still notify the Federal Aviation  
5 Administration in accordance with 14 CFR 77.9 (TN7902) before building any of the Hermes  
6 structures. Upon receipt of the notification, the Federal Aviation Administration would officially  
7 verify that none of the proposed Hermes structures constitutes a flight obstruction.

8 **3.1.6 Conclusions**

9 The NRC staff concludes that the potential direct, indirect, and cumulative land use and visual  
10 resource impacts of the proposed action would be SMALL. This conclusion is based primarily  
11 on the fact that the proposed test reactor and support facilities are consistent with the objectives  
12 of the Heritage Center as well as the site's zoning and are functionally and visually compatible  
13 with the existing and anticipated future land uses surrounding the site. Reuse of former  
14 industrial land provides the economic benefits of the test reactor without requiring the  
15 conversion of sensitive lands such as forests, wetlands, or agricultural land for industrial use.  
16 Use of the site would also take advantage of existing roadways and utilities at the Heritage  
17 Center.

18 **3.2 Air Quality and Noise**

19 Section 3.2.1 addresses air quality, and Section 3.2.2 addresses noise.

20 **3.2.1 Meteorology and Air Quality**

21 **3.2.1.1 Affected Environment**

22 **3.2.1.1.1 Climatology and Local Meteorology**

23 The proposed site is located in an area of Tennessee commonly referred to as "The Great  
24 Valley" (Kairos 2021-TN7880 | Sec 3.2.1). This area is dominated much of the year by the  
25 Azores-Bermuda anti-cyclonic circulation, which is most pronounced in late summer and early  
26 fall and is accompanied by extended periods of fair weather and widespread atmospheric  
27 stagnation. Frequent incursions of warm, moist air from the Gulf of Mexico and occasionally  
28 from the Atlantic Ocean are experienced in the summer. In winter and early spring, eastward-  
29 moving migratory high- or low-pressure systems bring alternately cold and warm air masses into  
30 the area (Kairos 2021-TN7880 | Sec 3.2.1).

31 To characterize the region's climate, the applicant used climatological data collected from  
32 multiple sources including data from the National Climatic Data Center. Data were gathered  
33 from multiple meteorological towers at nearby airports and from meteorological towers located  
34 on the ORR (Kairos 2021-TN7880 | Sec 3.2.1-3.2.5). Local meteorology data were gathered  
35 using multiple sources including three meteorological towers located on the ORR (ORR Tower  
36 J, Tower L, and Tower D). Data from all three towers were used to evaluate the impact of  
37 topography on site meteorology, and Kairos relied upon existing measurements taken within  
38 ORR to address pre-operational site-specific meteorological monitoring. On May 6, 2021,  
39 Tower L was decommissioned because the land it occupies was ceded by the DOE to another  
40 party. The tower will not be relocated; instead, it has been replaced with a wind light detection  
41 and ranging measurement program (using a Vaisala WindCube remote-sensing lidar  
42 instrument) (Kairos 2021-TN7880 | Sec 3.2.4.3).

1 Average wind speeds in the region are low, with a mean annual wind speed of 2.1 miles per  
2 hour (mph) at Oak Ridge (Kairos 2021-TN7880 | Sec 3.2.1). During winter when the jet stream  
3 moves southward, the Cumberland Mountains serve to moderate cold outbreaks by blocking  
4 dense, cold polar continental air masses; and during the summer they reduce the intensity of  
5 thunderstorms produced by synoptic-scale systems crossing the region due to the downward  
6 momentum of the air mass as it comes off the higher terrain and moves into the Great Valley.  
7 Therefore, thunderstorms are more frequently caused by atmospheric heating from the land  
8 during the day; and the orographic lift produced by the local topography may enhance these  
9 thunderstorms (Kairos 2021-TN7880 | Sec 3.2.1).

10 Area temperatures at Oak Ridge indicate warm summers and mild winters (Kairos 2021-  
11 TN7880 | Sec 3.2.1). In January, the normal daily maximum temperature is about 47 degrees  
12 Fahrenheit (°F) with a normal daily minimum temperature of about 29 °F, based on 30 years of  
13 data. In July, the normal daily maximum temperature is about 88 °F, while the normal daily  
14 minimum temperature is about 69 °F based on 30 years of data (1981–2010) from the National  
15 Climatic Data Center. Relative humidity in the region, measured at Knoxville, Tennessee,  
16 averaged 73 percent based on 30 years of data from National Climatic Data Center (1981–  
17 2010) (Kairos 2021-TN7880).

18 Precipitation averages about 51 inches (in.) annually. Late winter (January–March) is usually  
19 the wettest season, with more than 14 in.; while late summer–early autumn (August–October) is  
20 the driest season, with less than 10 in. (Kairos 2021-TN7880 | Sec 3.2.1). Droughts are  
21 uncommon. Snowfall, though normally light, usually occurs between November and March  
22 (Kairos 2021-TN7880 | Sec 3.2.1).

23 Severe weather events include extreme wind; tornadoes and waterspouts; water precipitation  
24 extremes; hail, snowstorms, and ice storms; thunderstorms and lightning; snowpack and  
25 probable maximum winter precipitation; extreme temperatures; and restrictive dispersion  
26 conditions. The applicant discusses severe weather events for the proposed site in Section  
27 3.2.3 of the ER (Kairos 2021-TN7880 | Sec 3.2.3).

28 Atmospheric stability is a critical parameter for estimating atmospheric dispersion characteristics.  
29 Pasquill atmospheric stability is a method of categorizing the atmospheric stability of a region in  
30 terms of the horizontal surface wind, the amount of solar radiation, and the fractional cloud cover  
31 where Class A is extremely unstable conditions, Class B is moderately unstable conditions,  
32 Class C is slightly unstable conditions, Class D is neutral conditions, Class E is slightly stable  
33 conditions, Class F is moderately stable conditions, and Class G is extremely stable conditions  
34 (NOAA 2022-TN7904 and AMS 2012-TN7905). One typical method for computing atmospheric  
35 stability is based on the temperature difference between two tower measurement levels, e.g.,  
36 between the upper and lower measurement levels. The frequency of occurrence of Pasquill  
37 (Classes A–G) atmospheric stability classes at the site were based upon temperature differences  
38 for local ORR meteorological Tower L over a two-year period (2018–2019) (Kairos 2021-TN7880  
39 | ER Sec 3.2.4.5). While the atmosphere at the site for the 2 years analyzed appears to be  
40 almost equally stable, neutral, and unstable, the stable lapse conditions (Classes E, F, and G;  
41 i.e., inversions) occur much of the time (42 percent). However, the majority of the stable lapse  
42 conditions are only slightly stable (Class E), occurring 27 percent of the time. The most stable  
43 class (Class G) occurs approximately 5.5 percent of the time. Neutral lapse conditions (Class D)  
44 occur approximately 27 percent of the time. Unstable class conditions (Classes A, B, and C)  
45 occur approximately 31 percent of the time (Kairos 2021-TN7880 | Sec 3.2.5).

1      **3.2.1.1.2 Air Quality**

2      The region of influence for this air quality analysis is Roane County. In accordance with the  
3      Federal Clean Air Act of 1970, as amended (CAA) (Clean Air Act-TN1141), the U.S.  
4      Environmental Protection Agency (EPA) established National Primary and Secondary Ambient  
5      Air Quality Standards (40 CFR Part 50-TN1089) for six pollutants (often referred to as criteria  
6      pollutants) to protect the environment and public health. These pollutants include ozone ( $O_3$ ),  
7      carbon monoxide (CO), nitrogen dioxide ( $NO_2$ ), sulfur dioxide ( $SO_2$ ), lead (Pb), and particulate  
8      matter (PM). PM includes particles less than 10 micrometers ( $\mu m$ ) in diameter and particles  
9      less than 2.5  $\mu m$  in diameter—particles that have equivalent aerodynamic diameters less than  
10     or equal to 10 and 2.5  $\mu m$ , respectively. Other air pollutants of concern include greenhouse  
11     gases (GHGs), such as carbon dioxide ( $CO_2$ ) and methane ( $CH_4$ ), and hazardous air pollutants  
12     (HAPs).

13     National Ambient Air Quality Standards (NAAQS) limit the concentrations of the six criteria  
14     pollutants in order to protect human health and welfare. Areas in which pollutant concentrations  
15     exceed these standards are designated as “nonattainment areas” because air quality levels do  
16     not meet the required standards. “Attainment areas” are areas in which recent monitoring data  
17     demonstrate that concentrations of criteria pollutants are lower than the NAAQS. If monitoring  
18     has been insufficient to determine whether an area meets the standards, the area is designated  
19     as an “unclassifiable area.”

20     The CAA (TN1141) requires development of regulatory plans for nonattainment areas to reduce  
21     pollution levels until the area meets the NAAQS within a specified timeframe. State agencies  
22     typically complete these plans, called state implementation plans, which are then approved by  
23     the EPA. After air quality has improved in an area to the point that monitoring data demonstrate  
24     the air quality requirements outlined in the NAAQS, the area is designated as a “maintenance  
25     area.”

26     Air quality designations are generally made at the county-level, but designations may also be  
27     made for smaller localized areas. The City of Oak Ridge spans parts of Roane and Anderson  
28     Counties, which are part of the Knoxville-Sevierville-LaFollette, Tennessee air quality area  
29     (Kairos 2021-TN7880 | Sec 3.2.2). The immediate areas of Roane and Anderson Counties are  
30     currently in attainment for all criteria pollutants. Parts of Roane County were in nonattainment  
31     for several years for  $PM_{2.5}$  and were redesignated to maintenance status in 2017. Similarly,  
32     Anderson County was in nonattainment for several years for eight hour ozone and  $PM_{2.5}$  but  
33     was redesignated to maintenance status in 2015 for eight hour ozone and in 2017 for  $PM_{2.5}$   
34     (EPA 2022-TN7906). While the immediate area surrounding the proposed facilities is in  
35     attainment for all criteria pollutants, it is approximately 5 mi away from an area designated as a  
36     maintenance area for  $PM_{2.5}$ . Because areas within Roane County are designated as  
37     maintenance areas, the NRC staff uses the thresholds for maintenance areas when determining  
38     the impacts from NAAQS emissions to understand whether the project could potentially further  
39     degrade the air quality in those maintenance areas. Table 3-1 presents the national thresholds  
40     contained in 40 CFR 93.153 (TN2495) for maintenance areas.

41     HAPs are pollutants known or suspected to cause cancer or other serious health effects, such  
42     as reproductive effects, birth defects, or adverse environmental effects. Under the CAA  
43     (TN1141), the EPA regulates a list of 188 HAPs (EPA 2022-TN7907).

1      **Table 3-1 National Ambient Air Quality Standards for Maintenance Areas**

Criteria Pollutant	Threshold (TPY)
Ozone ( $O_3$ ), nitrogen oxides ( $NO_x$ ), $SO_2$ or $NO_2$ All maintenance areas	100
Ozone ( $O_3$ ), (volatile organic compounds [VOC]) Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
CO All maintenance areas	100
PM <sub>10</sub> All maintenance areas	100
PM <sub>2.5</sub> Direct emissions, $SO_2$ , $NO_x$ , VOC, and ammonia All maintenance areas	100 100
Pb All maintenance areas	25

2      Key: TPY = ton(s) per year;  $O_3$  = ozone;  $NO_x$  = nitrogen oxides,  $SO_2$  = sulfur dioxide;  $NO_2$  = nitrogen dioxide; volatile  
3      organic compounds = VOC; CO = carbon monoxide; PM = particulate matter; Pb = lead.

4      Source: 40 CFR Part 93-TN2495.

5      EPA promulgated the Regional Haze Rule to improve and protect visibility in national parks and  
6      wilderness areas from haze that many diverse sources across a broad region may cause  
7      (40 CFR 51.308–51.309) (TN1090). Specifically, 40 CFR Part 81 (TN255), Subpart D, lists  
8      mandatory Class I Federal Areas where visibility is an important value. The Regional Haze  
9      Rule requires states to develop regional haze state implementation plans to reduce visibility  
10     impairment at Class I Federal Areas (40 CFR 51.300 through 51.309) (TN1090). The closest  
11     two Federal Class I areas are approximately 62 mi from the site: Joyce Kilmer-Slickrock  
12     Wilderness Area and Great Smoky Mountains National Park. (Kairos 2021-TN7880 | Sec  
13     3.2.2). If the proposed project is a major source of emissions and within approximately 31 mi  
14     (50 kilometers [km]) of a Class I area, then a Class I visibility impact analysis would be  
15     completed (NPS 2010-TN7925).

#### 16      *3.2.1.1.3 Federal and State New Source Permitting Requirements*

17      New facilities that emit air pollutants, such as the proposed Hermes facilities, could be subject to  
18      Federal requirements, depending on the location and the type and amount of emitted air  
19      pollution. The following sections summarize these requirements.

#### 20      Prevention of Significant Deterioration and Nonattainment New Source Reviews

21      The New Source Review regulations are broken down into two separate programs: Prevention  
22      of Significant Deterioration (PSD) and Nonattainment New Source Review. PSD is a Federal  
23      permitting program that applies to sources classified as major sources (as defined in 40 CFR  
24      52.21) (TN4498) under the PSD program and located in attainment areas. The purpose of the  
25      program is to prevent degradation of air quality in areas where air quality is good. New or  
26      modified sources of criteria pollutants that exceed de minimis emission rates are subject to the  
27      program. For purposes of this air quality analysis, the 250 tons per year (TPY) of any criteria  
28      pollutant threshold (40 CFR 52.21) (TN4498) will be considered when determining the  
29      significance of air quality impacts for operation. A nonattainment new source review applies to  
30      new major sources or major modifications at existing sources for pollutants at a source location

1 that is within a NAAQS nonattainment area (Part D of Title I of the CAA) (TN1141).  
2 Nonattainment new source review requirements are customized for the nonattainment area. All  
3 nonattainment new source review programs require (1) the installation of the lowest achievable  
4 emission rate, (2) emission offsets, and (3) opportunity for public involvement (EPA 2022-  
5 TN7908). Minor new source reviews are for pollutants from stationary sources that do not  
6 require PSD or nonattainment new source review permits. The purpose of minor new source  
7 review permits is to prevent the construction of sources that would interfere with attainment or  
8 maintenance of a NAAQS or violate the control strategy in nonattainment areas (EPA 2021-  
9 TN7909). Emissions from new sources are evaluated by the State of Tennessee through the  
10 PSD program (EPA 2022-TN7910).

11 Title V of the Clean Air Act

12 Title V of the CAA (TN1141) requires a Federally enforceable operating permit program that  
13 applies to large, new, and existing sources of air pollution. Any facility with the potential to emit  
14 100 TPY or more of any criteria pollutant, 10 TPY of any HAP, or 25 TPY of any combination of  
15 HAPs is required to obtain a valid Title V permit and is considered a major air emission source  
16 (EPA 2022Q). For purposes of this air quality analysis, the 100 TPY of any criteria pollutant  
17 threshold for a Title V operation permit will be considered in determining the significance of air  
18 quality impacts for operation. The applicant would be required to obtain a permit from the  
19 Tennessee Department of Environment and Conservation (TDEC) (EPA 2022-TN7910).

20 Greenhouse Gas Rules

21 In September 2009, the EPA issued a final rule for mandatory GHG reporting by large GHG  
22 emission sources in the United States (74 FR 56260-TN1024). The purpose of the rule is to  
23 collect and use comprehensive and accurate data about CO<sub>2</sub> and other GHG emissions to  
24 inform future policy decisions. In general, the threshold for reporting is 25,000 metric tons (MT)  
25 or more of carbon dioxide equivalent (CO<sub>2</sub>eq)<sup>1</sup> emissions per year, excluding mobile-source  
26 emissions.

27 In May 2010, the EPA issued the GHG Tailoring Rule. This rule set the thresholds for a phase-  
28 in approach to regulating GHG emissions under the PSD and Title V permitting programs (75  
29 FR 31514-TN1404). According to the rule, operating permits issued to major sources of GHG  
30 under the PSD or Title V Federal permit programs must contain provisions requiring the use of  
31 best available control technology to limit the emissions of GHGs, if those sources would be  
32 subject to PSD or Title V permitting requirements because of their non-GHG pollutant emission  
33 potentials and if their estimated GHG emissions are at least 75,000 TPY of CO<sub>2</sub>eq. In June  
34 2014, the U.S. Supreme Court issued its decision in *Utility Air Regulatory Group v. EPA*, 573  
35 U.S. 302 (2014), in which it held that EPA may not treat GHGs as an air pollutant for  
36 determining whether a source is a major source required to obtain a PSD or Title V permit. The  
37 Court also stated that EPA could continue to require PSD and Title V permits otherwise required  
38 based on emissions of conventional pollutants (*Utility Air Regulatory Group v. Environmental*  
39 *Protection Agency et al.* 2014-TN7924).

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<sup>1</sup> The CO<sub>2</sub>eq is a metric used to compare the emissions of GHGs based on their global warming potential (GWP). GWP is a measure used to compare how much heat a GHG traps in the atmosphere. GWP is the total energy that a gas absorbs over a period of time compared to CO<sub>2</sub>. The CO<sub>2</sub>eq is obtained by multiplying the amount of the GHG by the associated GWP.

1    State Air Quality Permitting

2    Unless specifically exempted, any person wishing to construct an air emission source or to  
3    modify an existing air emission source is required to obtain a CP from the Tennessee Division of  
4    Air Pollution Control (TDAPC; TDEC 2022-TN7911).

5    Under Tennessee law, air contaminant sources typically are classified as major or minor  
6    sources depending on their potential to emit pollutants. Major sources generally are:

- 7    • sources that are in specific source categories listed in Part 1200-03-09-.01(4)(b)1 of the  
8    Tennessee Air Pollution Control Regulations and have potential total facility emissions  
9    greater than 100 TPY; and
- 10   • other sources with potential total facility emissions greater than 250 TPY or more of the  
11   following criteria pollutants: carbon monoxide (CO), particulate matter (PM), nitrogen  
12   dioxide, sulfur dioxide (SO<sub>2</sub>), lead (Pb) and ozone (O<sub>3</sub>) (indirectly determined from emissions  
13   of volatile organic compounds (VOCs) and nitrogen oxides (NOx).

14   Examples of major sources are large power plants, chemical manufacturers, some secondary  
15   metal production facilities, and large printing operations (TDEC 2022-TN7911).

16   Minor sources are sources of air contaminants that are not major sources and are not  
17   specifically exempt from the CP requirements of Tennessee. Examples include concrete batch  
18   plants and small surface coating and printing operations (TDEC 2022-TN7911).

19   *3.2.1.1.4 Environmental Impacts of Construction*

20   During construction, air quality may be affected near the proposed facilities. Air pollutants  
21   would include fugitive dust from earth-moving equipment and other vehicles, exhaust gases  
22   from diesel engines, and exhaust gases from worker vehicles and delivery vehicles as they  
23   commute to and from the proposed facilities. These activities generate combustion product  
24   emissions such as carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) and, to a lesser extent, sulfur  
25   dioxide (SO<sub>2</sub>). Painting, coating, and similar activities during construction generate emissions  
26   from the use of volatile organic compounds. Over the two-year construction schedule, the  
27   applicant estimates a monthly average of 213 truck deliveries, 4 offsite shipments of  
28   construction debris, and an average of 212 onsite workers with a peak construction workforce  
29   estimated to be 425 (Kairos 2021-TN7880 | Sec 2.1). Table 3-2 lists the air emission estimates  
30   for the project for criteria pollutants during the two-year construction phase. The estimates of air  
31   emissions for all criteria pollutants are below the thresholds presented in Table 3-1. The  
32   applicant would still be required to apply for any needed state air quality permits for minor  
33   sources for construction. Because the proposed project is not a major source, and the project is  
34   more than 31 mi (50 km) away from the nearest Class 1 area, a Class I visibility impact analysis  
35   is not needed. Lastly, the HAPs are estimated to be below 10 TPY for any single pollutant and  
36   below 25 TPY for all HAPs combined (Kairos 2021-TN7880 | Sec 4.2.1.1).

37   Impacts from fugitive dust and other air emissions could be further reduced by mitigation  
38   measures and would reduce impacts on local ambient air quality and impacts on the site and  
39   nearby offsite areas. According to the applicant (Kairos 2021-TN7880 | Sec 4.2.1.1), specific  
40   mitigation measures available to control air emissions including fugitive dust could include any  
41   or all of the following:

- 42   • stabilizing construction roads and spoil piles;

- limiting speeds on unpaved construction roads;
- periodically watering unpaved construction roads;
- performing housekeeping (e.g., remove dirt spilled onto paved roads);
- covering haul trucks when loaded or unloaded;
- minimizing material handling (e.g., drop heights, double-handling);
- phased grading to minimizes the area of disturbed soils;
- re-vegetating road medians and slopes;
- implementing controls to minimize daily emissions such as reducing engine idle time, using cleaner fuels (e.g., ultra-low sulfur diesel fuel or biodiesel), using pollution control equipment on construction equipment (e.g., diesel oxidation catalysts and particulate matter filters), and curtailing or controlling the time-of-day construction activities are performed; and
- proper maintenance of construction vehicles to maximize efficiency and minimize emissions.

**Table 3-2 National Ambient Air Quality Standards Air Emissions During Construction for Hazardous Air Pollutants**

Emission Effluent	Emissions During Construction (T) <sup>(a)</sup>
NO <sub>x</sub>	5.79
CO	2.49
Sulfur oxides (SO <sub>x</sub> )	0.10
VOC	0.51
PM <sub>10</sub>	0.40
PM <sub>2.5</sub>	0.38

Key: T = ton(s); NO<sub>x</sub> = nitrogen oxides, CO = carbon monoxide; SO<sub>x</sub> = sulfur oxides; volatile organic compounds = VOC; PM = particulate matter.

<sup>(a)</sup> The emissions totals presented in Table 3.2-2 are for the two-year construction period.

Source: (Kairos 2022-TN7912).

### *3.2.1.1.5 Environmental Impacts of Operation*

Air emissions of nonradiological gaseous criteria pollutants and HAPs would be emitted during the operation phase from (1) intermittent use of diesel-powered or natural gas powered standby power generation sources such as generators or combustion gas turbines, (2) intermittent use of propane-fired heaters for the intermediate coolant located in the primary heat rejection system during maintenance activities, (3) diesel-powered trucks that deliver material and haul off wastes, and (4) worker commuter vehicles (Kairos 2021-TN7880). Shipment-related emissions could be emitted beyond the region of interest (ROI) and would traverse various counties, air quality control regions, and states; therefore, the air quality analysis presented below focuses on emissions from generators, combustion gas turbines, delivery trucks and waste removal, and worker commuting. Because the proposed Hermes facilities would not have cooling towers, the analysis does not address issues related to cooling tower operation such as salt drift, ground-level fogging and icing, plume shadowing, and ground-level temperature and humidity increases.

Table 3-3 lists the air emission estimates during operation for criteria pollutants for the proposed Hermes facilities. The applicant stated in its ER that emissions from the proposed Hermes facilities would be smaller than those estimated by Tennessee Valley Authority (TVA) from its small modular nuclear reactor at the CRN site (Kairos 2022-TN7912). The Clinch River early

1 site permit (ESP) EIS analyzed air emissions and included emissions from auxiliary boilers and  
2 cooling towers (Kairos 2022-TN7912). The NRC staff incorporated by reference Table 5-3 from  
3 the CRN ESP EIS, and because the proposed Hermes facilities are not expected to use  
4 auxiliary boilers or cooling towers, the staff removed the emission estimates from those sources  
5 to create Table 3-3. Intermittent emissions from standby power generation sources such as  
6 generators or combustion gas turbines would operate less than 500 hr/yr and would produce  
7 insignificant emissions (less than 5 TPY for criteria pollutants and less than 1,000 pounds (lb)  
8 per year for an individual HAP), as defined in Chapter 1200-03-09 of the Tennessee Air  
9 Pollution Control Regulations. If used exclusively for replacement or standby service and at or  
10 less than 500 hr/yr, these generator units would not require a construction or operating permit,  
11 as outlined in Chapter 1200-3-9-04 (construction and operating permits) of the Tennessee Air  
12 Pollution Control Regulations (Kairos 2021-TN7880 | Sec 4.2.1.2.2).

13 **Table 3-3 National Ambient Air Quality Standards Annual Air Emissions During  
14 Operation**

Emission Effluent	Emissions During Construction (TPY) <sup>(a)</sup>
NO <sub>x</sub>	20.65
CO	1.85
SO <sub>x</sub>	0.0125
VOC <sup>(b)</sup>	0.3575
PM (PM <sub>10</sub> ) <sup>(c)</sup>	0.15

15 Key: TPY = ton(s) per year; NO<sub>x</sub> = nitrogen oxides; CO = carbon monoxide; SO<sub>x</sub> = sulfur oxides; volatile organic  
16 compounds = VOC; PM = particulate matter.

17 (a) Emissions from diesel generators and gas turbines are based on four-hour of operation per month.

18 (b) As total hydrocarbon.

19 (c) The emission estimates for PM<sub>10</sub> ( $\leq 10 \mu\text{m}$ ) encompass the PM<sub>2.5</sub> ( $\leq 2.5 \mu\text{m}$ ) emissions.

20 Source: Adapted from (NRC 2019-TN6136), (Kairos 2022-TN7912).

21 The estimates of air emissions for all criteria pollutants are below the thresholds presented in  
22 Table 3-1. The estimated emissions are well below the thresholds for the Title V and PSD  
23 permits discussed above. In addition, because the project is located in an attainment area for  
24 all criteria pollutants, the proposed project is not subject to a Nonattainment New Source  
25 Review. Because the proposed project is not a major source, and the project is more than  
26 31 mi (50 km) away from the nearest Class 1 area, a Class I visibility impact analysis is not  
27 required. Lastly, the HAPs are estimated to be below 10 TPY for any single pollutant and below  
28 25 TPY for all HAPs combined during operation (Kairos 2021-TN7880 | Sec 4.2.1.2).

### 29 *3.2.1.1.6 GHG Emissions*

30 Gases found in the Earth's atmosphere that trap heat and play a role in the Earth's climate are  
31 collectively termed GHGs. GHGs include CO<sub>2</sub>; CH<sub>4</sub>; nitrous oxide (N<sub>2</sub>O); water vapor (H<sub>2</sub>O);  
32 and fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride  
33 (SF<sub>6</sub>). Climate change is a subject of national and international interest because of how it  
34 changes the affected environment. *Commission Order CLI-09-21* ([NRC 2009-TN6406](#)) provides  
35 the current direction to the NRC staff to include the consideration of the impacts of the  
36 emissions of CO<sub>2</sub> and other GHGs that drive climate change in its environmental reviews for  
37 major licensing actions.<sup>1</sup> Estimates of GHG emissions from a reference 1,000 megawatt electric  
38 (MWe) reactor were developed using the approach in Interim Staff Guidance COL/ESP-ISG-026

1 The Commission stated that "the Staff's analysis for reactor applications should encompass emissions from the uranium fuel cycle as well as from construction and operation of the facility to be licensed" (CLI-09-21 [NRC 2009-TN6406], at 6).

1 (NRC 2014-TN3767), “Interim Staff Guidance on Environmental Issues Associated with New  
2 Reactors” (NRC 2014-TN3768), and the Council on Environmental Quality’s (CEQ’s) 2016 final  
3 guidance on considering GHGs emissions and effects of climate changes in NEPA reviews  
4 (CEQ 2016-TN4732), and are presented in Appendix E of this draft EIS.

5 GHGs are emitted from equipment and vehicles used during construction, operation, the  
6 uranium fuel cycle, transportation of fuel and waste, and decommissioning including extended  
7 SAFe STORage (SAFSTOR). Appendix E estimates GHG emissions for life-cycle phases for a  
8 reference 1,000 MWe reactor with an 80 percent capacity factor. The calculation of GHG  
9 emissions for the proposed Hermes facilities assumes that one 35 megawatt thermal (MWT)  
10 advanced reactor would be installed. Advanced reactors can have efficiencies of up to 45  
11 percent; therefore, the proposed facilities would generate approximately 15 Mwe, if it were  
12 producing electricity.<sup>1</sup> Assuming that GHG emission estimates for construction, operation, and  
13 decommissioning, including extended SAFSTOR for the proposed Hermes plant, would be  
14 based on the plant’s physical size, the estimates for these stages would be scaled down to  
15 1.5 percent of the totals calculated in Appendix E. No additional scaling was needed to account  
16 for the size or number of the reactors at the proposed site. However, GHG emission estimates  
17 for the uranium fuel cycle and transportation of fuel and waste would be based on the  
18 anticipated efficiency of the proposed plant. To provide bounding values, the estimates for  
19 GHG emissions for uranium fuel cycle activities and fuel and waste transport associated for the  
20 proposed Hermes facilities the staff calculated the values as 1.5 percent of the totals presented  
21 for the reference 1,000 MWe reactor in Appendix E multiplied by 3 to account for the efficiency  
22 of the reactor. Consistent with the approach used in Appendix E, which is based on COL/ESP-  
23 ISG-26, the staff halved the emissions estimated for the construction equipment and workforce  
24 calculated for the proposed Hermes facilities to determine the estimates for GHG emissions  
25 during decommissioning. The staff expects that, for a small reactor such as the proposed  
26 Hermes project, the SAFSTOR workforce would be much less than that for a power reactor  
27 similar to those currently licensed in the United States, so the staff halved the emissions  
28 estimate. Additionally, to add conservatism to the calculation the staff did not change the life  
29 cycle assumed in Appendix E. The staff calculated that the GHG emissions for the proposed  
30 Hermes facilities to be approximately 37,000 MT CO<sub>2</sub>eq using the assumptions discussed  
31 above to scale the reference 1,000 MWe reactor in Appendix E. These emissions can be  
32 compared with 2019 total gross annual U.S. energy sector emissions of 5,410.8 million metric  
33 ton (MMT) CO<sub>2</sub>eq (EPA 2021-TN6965). Even when taking the conservative approach and  
34 comparing the entire life cycle estimated GHG emissions from construction, operation, uranium  
35 fuel cycle, transportation of fuel and waste, and decommissioning activities to the 2019, the total  
36 gross annual U.S. energy sector emissions the project’s GHG emissions are about  
37 0.00068 percent of the 2019 GHG emissions from the U.S. energy sector.

38 *3.2.1.1.7 Environmental Impacts of Decommissioning*

39 Decommissioning includes decontamination and dismantling facilities to the ultimate end state  
40 of demolition (Kairos 2021-TN7880 | Sec 4.2.1.3). Demolition includes the recycling of  
41 demolition materials to the extent practical and the disposal of non-recyclable materials. During  
42 the decommissioning phase, activities, equipment usage, and their associated emissions are  
43 expected to be similar, but less than those during the construction phase because  
44 decommissioning activities are less extensive than construction activities (Kairos 2021-TN7880  
45 | Sec 4.2.1.3).

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<sup>1</sup> The proposed Hermes facilities will host a test reactor and will not be producing electricity for use on the grid (Kairos 2022-TN7881). The 15 MWe value is for calculating the GHG emissions for the proposed facilities.

1      **3.2.1.1.8 Cumulative Impacts**

2      Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
3      could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
4      TN7880). Key past, present, and reasonably foreseeable actions affecting air quality in the  
5      region include the Federal nuclear and energy development facilities on the ORR such as the  
6      Y-12 Plant, ORNL, and the proposed CRN site. Continued development including  
7      transportation projects, new industrial facilities, and new large-scale residential development will  
8      affect local air quality. Continued operation of industrial parks and energy facilities such as TVA  
9      fleet (i.e., Kingston Fossil Plant) will also affect air quality (Kairos 2021-TN7880 | Table 4.13-1).  
10     New projects would all be governed by new construction air permits processed through TDEC.  
11     The permit process would ensure that counties potentially impacted would continue to be in  
12    attainment or maintenance. Additionally, any facilities that are currently operating would  
13    continue to operate within their permit limits. Permitting reviews performed by the TDEC are  
14    conducted to ensure that new permits do not result in regional air quality degradation. The  
15    incremental impact on air quality from construction, operation, and decommissioning activities  
16    from the proposed facilities would not be significant.

17     **3.2.1.1.9 Conclusions**

18     The NRC staff concludes that the potential direct, indirect, and cumulative meteorology and air  
19    quality impacts of the proposed action would be **SMALL**. Air emissions from the proposed  
20    Hermes facilities are well below all thresholds considered in the analysis and would not be a  
21    major source of air emissions. GHG emissions would be 0.00068 percent of the overall energy  
22    sector, and the potential changes to the affected environment as a result of climate change  
23    would not change the conclusions discussed in this DEIS.

24     **3.2.2      Noise**

25     **3.2.2.1      Affected Environment**

26     Noise is unwanted or unwelcome sound usually caused by human activity that is added to the  
27    natural acoustic setting (Kairos 2021-TN7880 | Sec 3.2.6). Although sound pressure levels are  
28    measured in decibels (dB), noise levels in environmental analyses are commonly expressed  
29    using A-weighted sound levels (dBA) that are adjusted to better reflect how the human ear  
30    perceives the sound. The applicant correlates ranges of dBA levels to common noise  
31    experiences in Section 3.2.6 of the ER (Kairos 2021-TN7880 | Sec 3.2.6). A change of at least  
32    3 dBA is necessary for most people to perceive an increase in noise, while a change of 5 dBA  
33    would be readily noticeable (Kairos 2021-TN7880 | Sec 3.2.6). The applicant notes that the  
34    nearest noise receptors within a 5 mi radius of the Hermes site include two parks (the adjacent  
35    Black Oak Ridge Conservation Easement and the Oak Ridge Country Club 4.9 mi to the  
36    northeast), one rehabilitation facility (Michael Dunn Center, approximately 4.6 mi southwest),  
37    and several churches (Kairos 2021-TN7880 | Sec 3.2.6). The nearest resident is situated  
38    approximately 1.1 mi to the northwest. There are also other noise contributors in the area, such  
39    as a railroad station and yard to the west, a marina approximately 2 mi southwest, and ORNL  
40    facilities; other new noise sources, including a new airport approximately 1.1 mi south of the  
41    site, are anticipated (Kairos 2021-TN7880 | Sec 3.2.6).

42     The applicant conducted baseline noise monitoring in June 2021 for two locations (Kairos 2021-  
43    TN7880 | Sec 3.2.6), one inside the proposed Hermes site and one on the boundary of the site  
44    (Kairos 2021-TN7880 | Figure 3.2-22). The applicant chose the location inside the currently  
45    undeveloped site to be representative of nearby areas away from publicly accessible roads and

1 chose the location on the site boundary to be representative of nearby areas close to publicly  
2 accessible roads (Kairos 2021-TN7880 | Sec 3.2.6). The results of the baseline noise  
3 measurements are presented in Tables 3.2-9 and 3.2-10 of the ER (Kairos 2021-TN7880).  
4 The tables show a baseline Day-Night Sound Level ( $L_{dn}$ ) of 53 dBA at the location on the site  
5 boundary and of 46 dBA at the quieter location inside the site. A  $L_{dn}$  refers to a 24-hour average  
6 noise level with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m. due to  
7 increased sensitivity to noise during those hours (Kairos 2021-TN7880 | Sec 3.2.6).

8     3.2.2.2   *Environmental Impacts of Construction*

9 Construction noise would cause temporary increases and fluctuations in noise levels around the  
10 site during an anticipated two-year construction period between 2023 and 2025. The applicant  
11 reported that the existing ambient noise level at two sensitive locations close to the proposed  
12 Hermes site, one a greenway approximately 1 mi away (the nearest park) and the other  
13 approximately 1.1 mi away (the nearest resident), was measured at an average noise level ( $L_{eq}$ )  
14 of 38 dBA (Kairos 2022-TN7912). The applicant then calculated projected noise levels at each  
15 of the two sensitive locations of each type of construction equipment likely to be used to build  
16 the proposed facilities (Kairos 2022-TN7912). Projected noise levels  $L_{eq}$  from use of most  
17 construction equipment at the nearest residence and park would not increase by more than  
18 3 dBA over the ambient level of 38 dBA and therefore would not likely be perceptible to persons  
19 at the two sensitive locations (Kairos 2022-TN7912). The applicant notes that operation of a  
20 pile driver vibratory hammer, or simultaneous operation of multiple pieces of heavy equipment,  
21 could increase noise levels by more than 3 dBA (Kairos 2022-TN7912) and therefore could be  
22 perceptible to persons at the two sensitive locations. The applicant also notes that  
23 simultaneous operation of multiple types of construction equipment may result in perceptible  
24 noise increases for temporary periods (Kairos 2022-TN7912). The NRC staff reviewed the  
25 information provided in the ER and finds the applicant's conclusions to be reasonable. The  
26 NRC staff further notes that any perceived noise increases would likely be typical of  
27 construction sites in industrial parks such as the Heritage Center, and that forest cover  
28 separating the industrial areas from the nearest residential areas would help blunt the noise  
29 even if the noise might be perceptible. This would also be true regarding any temporary  
30 increases in noise from construction vehicles and equipment using local roadways to access the  
31 Hermes site. The NRC staff expects that the noise resulting from building the proposed Hermes  
32 facilities would not be objectionable to the Oak Ridge community.

33     3.2.2.3   *Environmental Impacts of Operation*

34 Operation of equipment at the proposed Hermes facilities would generate noise typical of  
35 industrial activities, but most equipment generating noise would be enclosed within buildings  
36 such as the reactor building, auxiliary building, and maintenance and storage building, which  
37 would minimize outdoor noise generation (Kairos 2022-TN7912). Operation of some outdoor  
38 equipment such as heat exchange fans, exhaust and ventilation stacks, and vehicles could  
39 generate operational noise perceptible in the immediate vicinity of the site (Kairos 2022-  
40 TN7912). However, because the site is situated within an existing industrial park, the  
41 operational noises can be expected to blend into and be consistent with other operational  
42 noises typical of an industrial park. Additionally, the nearest residential areas are more than a  
43 mile distant and separated by forest land. Based on the setting of the operation within an  
44 existing industrial park and the distance to nearby sensitive noise receptors, and the presence  
45 of forest cover between the site and the receptors, the NRC staff expects that area residents  
46 and users of public facilities in the area would not notice the operational noises of the facilities.

1    3.2.2.4    *Environmental Impacts of Decommissioning*

2    Noise generation during decommissioning is expected to be similar to, or less than that during  
3    construction (Kairos 2021-TN7880 | Sec 4.2.2.3). The decommissioning impacts from noise  
4    would be bounded by the analyses in the decommissioning generic EIS (NRC 2002-TN7254).  
5    Based on the analysis summarized above for construction, and the expected similarity of  
6    decommissioning noise to construction noise, the NRC staff expects that the noise resulting  
7    from decommissioning the proposed Hermes facilities would be brief and temporary, and not  
8    objectionable to the Oak Ridge community.

9    3.2.2.5    *Cumulative Impacts*

10   Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
11   could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
12   TN7880). Key past and present actions affecting noise in the affected area include the Federal  
13   nuclear and energy development facilities on the ORR such as the Y-12 Plant and ORNL.  
14   Continued development of the Heritage Center can be expected to increase noise levels to  
15   those of a typical industrial park, as can continued development of the Horizon Center to the  
16   east. The most likely noticeable increase in noise in the surrounding lands would be from  
17   operation of the proposed general aviation airport south of the site. DOE's EA for transfer of  
18   land to build the proposed airport states that cumulative noise levels with the airport would  
19   remain below levels considered compatible with residential areas (65 dBA L<sub>dn</sub>) (DOE 2016-  
20   TN7903 | Sec 3.3.2.1). Maps overlaying projected airport operational noise levels show that  
21   levels exceeding 55 dBA (L<sub>dn</sub>) would be confined to areas within approximately 3,000 feet (ft) of  
22   the new runway, encompassing portions of the southern part of the East Tennessee Technology  
23   Park and some lands immediately straddling Highway 58 (TN7903 | Figure 3.2). Airport  
24   operational noise levels shown on the map for what is now the proposed Hermes site and the  
25   sensitive receptors considered by the Hermes ER are at or below 40 dBA L<sub>dn</sub>, too low to  
26   substantially interact with noise generated by the Hermes facilities.

27   3.2.2.6    *Conclusions*

28   The NRC staff concludes that the potential direct, indirect, and cumulative land use impacts of  
29   the proposed action would be SMALL. Noise generated by use of pile driving equipment and  
30   multiple pieces of heavy construction equipment could be perceptible at some sensitive  
31   locations close to the site for brief periods, but the brief and temporary nature of the pile driver  
32   noise would likely prevent the noise from noticeably interfering with use and enjoyment of the  
33   affected properties. Otherwise, the noise generated by construction, operation, and  
34   decommissioning of the Hermes facilities would likely blend in with the expected noise levels  
35   expected from an active industrial park.

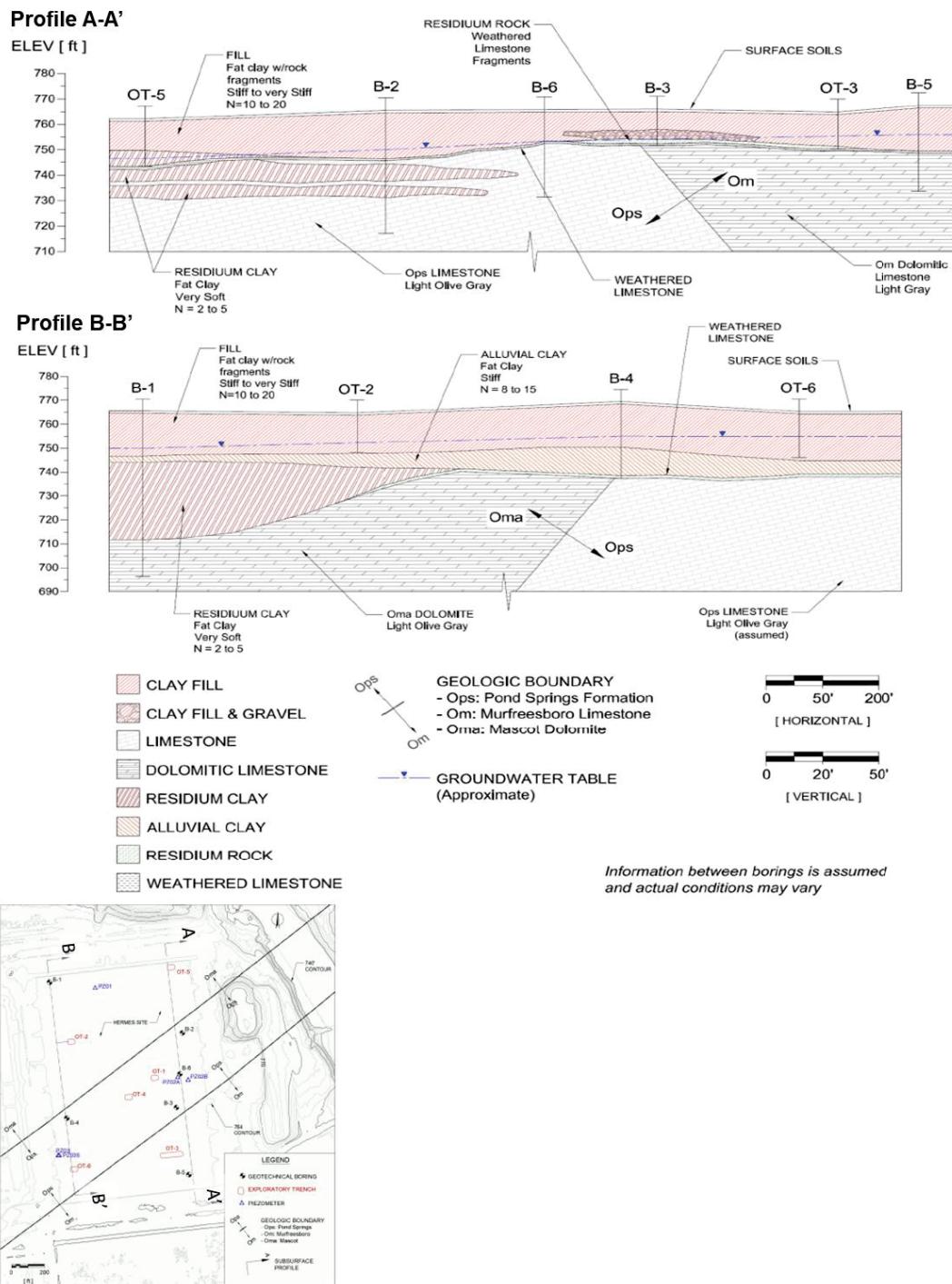
36   **3.3 Hydrogeology and Water Resources**

37   3.3.1    **Hydrogeology**

38   3.3.1.1    **Affected Environment**

39   The Hermes site is within the southwestern portion of the Valley and Ridge physiographic  
40   province. The province is characterized by a series of long, parallel ridges consisting primarily  
41   of limestone with interbedded shale and dolostone, and limestone bedrock following a northeast  
42   to southwest trend. The K-31/K-33 Area, which contains the proposed Hermes site, is underlain  
43   by bedrock of the upper Knox Group in the northern portion of the area, and the lower

1 Chickamauga Group formations occupy the southern portion of the area (DOE 2021-TN7913).  
 2 Weathering of these limestones and dolomites has produced approximately 20 ft of silt, sand,  
 3 and clay intermingled with alluvial material that is overlain by approximately 4 ft of  
 4 undifferentiated fill. The bedrock of the Knox and Stones River Group ranges between 20 to  
 5 40 ft below the ground surface at the Hermes site (Figure 3-1).



6  
 7 **Figure 3-1 Cross-Sections A-A' and B-B' Across the Hermes Site. Source: Kairos 2021-**  
 8 **TN7879**

1 Surface soils were previously reworked to accommodate the K-31 and K-33 building  
2 construction and their subsequent demolition and removal. After decontamination,  
3 decommissioning, and demolition, the slabs of the former buildings were removed or grouted  
4 into place to accommodate reindustrialization of the Hermes site (Kairos 2021-TN7880 | Sec  
5 3.3.3). Portions of the former building foundations have been encountered less than 12 ft below  
6 the ground surface (Kairos 2021-TN7880 | Sec 3.3.3.3). Recent investigations in the Hermes  
7 site area have included mapping of the K-25 site, a final remedial investigation of the East  
8 Tennessee Technology Park, an EA for the transfer of land and facilities within the East  
9 Tennessee Technology Park and surrounding area, and a K-31/K-33 groundwater remedial site  
10 evaluation report for the East Tennessee Technology Park (Kairos 2021-TN7880 | Sec 3.3.1).  
11 Geotechnical soil properties of the site soils are provided in the preliminary safety analysis  
12 report (PSAR) (Kairos 2021-TN7879 | Sec 2.5.2.2). Hermes site-specific investigations have  
13 included installation and evaluation of geotechnical borings, observation trenches, groundwater  
14 monitoring wells, and a laboratory testing program (Kairos 2021-TN7880 | Sec 3.3.3.3).

15 Primary potential geologic hazards within the Hermes site region include faults and sinkholes.  
16 Consistent with the northeast to southwest trending axis of the surface ridges and valleys, the  
17 faults follow a similar trend within the area of the Hermes site. Details of the local and regional  
18 seismicity are discussed in Section 2.5 of the PSAR (TN7879 | Sec 2.5). Preparation for  
19 construction of the K-31 and K-33 facilities in the early 1950s included minor leveling of the  
20 Hermes site and filling of karstic sinkholes (Kairos 2021-TN7880 | Sec 3.3.6). The Hermes site  
21 is not vulnerable to soil liquefaction, landslides, tsunamis, or volcanism due to the soil  
22 composition, geology, and surrounding geography of the site location.

23 **3.3.1.2 Environmental Consequences of Construction**

24 Building the proposed facilities would temporarily disturb approximately 138 ac of the site  
25 previously affected by industrial development and long-term operation. Primary effects on the  
26 geologic environment of deformation and disturbance would occur on a local scale due to  
27 excavation, exposure of potentially contaminated soils, and, if required for construction, bedrock  
28 blasting. The applicant stated that excavated material during Hermes site grading and  
29 construction would be stockpiled onsite and used as backfill, while unsuitable material would be  
30 placed as non-structural fill (Kairos 2021-TN7880 | Sec 4.3.2). The applicant anticipates that  
31 offsite borrow areas will not be needed (Kairos 2021-TN7880 | Sec 4.3.2). Construction effects  
32 would be temporary and localized. Before construction, topsoil would be removed, stockpiled or  
33 regraded, and potentially reused after decommissioning. Therefore, the common effects of  
34 construction on geology and soil resources from continued operation would be low.

35 The geology of the Hermes site and surrounding region is similar to the surrounding area with  
36 no rare or unique geologic resources, economically viable rock material, minerals, or energy  
37 resources, that could be affected. The potential for landslides and subsidence in Roane County  
38 is not considered high (Kairos 2021-TN7880 | Sec 4.3.1), and landslides on the relatively level  
39 Hermes site are very unlikely. The site has been previously disturbed during construction for  
40 the K-31/K-33 facilities. Anticipated construction on the Hermes site would not adversely affect  
41 the surface or subsurface geologic environment, given the applicant's implementation of grading  
42 permits and best management practices (BMPs) during grading, including a sediment and  
43 erosion control plan. Although the Hermes site area would be disturbed by excavation and  
44 grading, the disturbance would not be substantially greater than the disturbance from the  
45 previous construction and subsequent demolition of the former industrial buildings on the  
46 Hermes site.

1 For the Reactor Building and the Auxiliary Systems Building, the applicant anticipates an  
2 excavation depth of approximately 30 ft below a final grade of 765 ft. Utilities are anticipated to  
3 have a nominal depth of 5 ft below ground surface. The applicant estimated that other Hermes  
4 site buildings would have an excavation depth of approximately 10 ft below grade. An  
5 estimated total of approximately 113,000 cubic yards (cy or yd<sup>3</sup>) of material would be excavated  
6 and reused onsite. The applicant stated that the final Hermes site grading is to be determined  
7 based on material excavated onsite; however, grading activities would be managed to have  
8 minimal impact on the existing site drainage and topography (Kairos 2022-TN7902). Any  
9 potentially contaminated soils encountered would be managed in coordination with the DOE  
10 requirements for the property (TN7902). Construction mitigation strategies including  
11 construction BMPs, development of a Storm Water Pollution Prevention Plan (SWPP) in  
12 accordance with the rules of the TDEC, and implementation of the necessary erosion control  
13 measures would effectively minimize the impacts of soil erosion and soil compaction. The NRC  
14 staff finds that the effects of construction on the geologic environment would likely be low given  
15 that the implementation of mitigation strategies will need to be in compliance with local building  
16 code requirements.

17 **3.3.1.3 *Environmental Consequences of Operation***

18 Based on the NRC staff's evaluation of this CP application, no geologic resources would be  
19 used or altered during the four-year operational life of the facility; therefore, the facility would  
20 have a negligible effect on the geologic environment. At the OL stage, NRC staff will review the  
21 application for any new and significant information that might alter the staff's conclusions made  
22 for this CP application.

23 **3.3.1.4 *Environmental Consequences of Decommissioning***

24 Based on the information provided in this CP application, decommissioning would have little  
25 effect on the geologic environment because the Hermes site is a brownfield undergoing  
26 reindustrialization in a previously disturbed industrial park. In addition to NRC requirements for  
27 decommissioning, applicable demolition permits and BMPs would minimize the effects of  
28 decommissioning impacts on the geologic environment. Therefore, the NRC staff determined  
29 that no mitigation is necessary to minimize adverse geological environment impacts.

30 **3.3.1.5 *Cumulative Impacts***

31 Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
32 could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
33 TN7880). Soil erosion and sediment runoff is a typical effect of surface disturbances due to  
34 construction, operation, and decommissioning. Past, current, and reasonably foreseeable  
35 projects in the area would add to the total extent of disturbed soil permanently altering the  
36 building sites and soils. Within the Hermes site area, most of the proposed actions would take  
37 place in the reindustrialization area where similar construction of roads, parking lots, buildings,  
38 and utility lines has occurred or has been planned. The staff also recognizes that Kairos may  
39 build a planned fuel fabrication facility (referred to as Kairos Atlas Fuel Fabrication Facility or  
40 Atlas facility) on the same site as the Hermes reactor. The staff anticipates that the applicant  
41 would use the same construction BMPs described above in compliance with Federal, State and  
42 local environmental laws, rules, regulations and statutes in coordination with the DOE.

43 As with the adjacent Atlas facility, measures similar to those implemented at the proposed  
44 facility—such as securing appropriate construction and building permits and BMPs—would be

1 applied at these nearby projects, including erosion and sediment control measures, further  
2 limiting the compounded impact. Neither the existing projects nor the proposed action would  
3 further contribute to impacts on the geologic environment because there are no identified  
4 sensitive or economic geologic resources in the area and the proposed facility would be located  
5 in a previously disturbed reindustrialized area.

6     3.3.1.6     *Conclusions*

7     The NRC staff concludes that the potential direct, indirect, and cumulative geological impacts of  
8     the proposed action would be SMALL. This conclusion is based primarily on the lack of  
9     disturbances to areas of natural terrain and the fact that the disturbances to geology and soils  
10    that will occur would be limited to previously disturbed industrial lands of low economic value as  
11    geologic resources. Reuse of former industrial land provides the economic benefits of the test  
12    reactor without requiring the disturbance of natural ground or areas of economically viable  
13    geologic resources that have not been previously disturbed.

14    3.3.2     **Water Resources**

15    3.3.2.1    *Affected Environment*

16    Hydrologically, the 185-ac Hermes site is bounded by Poplar Creek to the east and south, the  
17    Clinch River arm of the Watts Bar Reservoir and secondary drainage features including the  
18    K-901 Holding Pond to the west, and a rapid increase in topography from approximately 765 ft  
19    at the Hermes site to over 1,000 ft just north of the site. Poplar Creek is a part of the Clinch  
20    River arm of the Watts Bar Reservoir (Kairos 2021-TN7880 | Sec 3.4.1.1), whose water levels  
21    and flow patterns are controlled by the power generation and release schedules of the Watts  
22    Bar, Fort Loudon, and Melton Hill Dams. During past decontamination, decommissioning and  
23    demolition of the former industrial facilities on the Hermes site, the upper 10 ft of surface soils  
24    were removed. Within the area of the Hermes site, the shallow aquifer materials predominately  
25    consist of clay with sandy clay lenses of the alluvial fill (Figure 3-1). Beneath the shallow  
26    aquifer, a deeper groundwater zone consists of weathered bedrock grading to fractures and  
27    joints of the underlying competent bedrock. Groundwater flow directions on the Hermes site are  
28    influenced by runoff infiltration from the highlands to the north and subsequent discharge to  
29    nearby surface water bodies. As indicated by DOE studies (TN7913 | Figures 3.1 and 3.2), the  
30    highland infiltration creates a radial groundwater flow pattern toward Poplar Creek to the east,  
31    Clinch River to the south, and secondary surface water drainage features to the west and  
32    southwest. Subsequent regrading has resulted in a relatively flat site with no distinguishable  
33    surface water drainage features.

34    Considering the past industrial history of the Hermes site and surrounding area, the  
35    groundwater and adjacent surface water bodies in the area are expected to be of a poor quality.  
36    Poplar Creek and the Clinch River arm of the Watts Bar Reservoir are considered impaired  
37    waters, as listed by the EPA (EPA 2021-TN7914). Both surface water features are impaired by  
38    mercury and polychlorinated biphenyls (PCBs), while pesticides are also listed for the Clinch  
39    River arm of the Watts Bar Reservoir (Kairos 2021-TN7880 | Sec 3.4.3.1). The primary  
40    pollutant in soils and sediment is mercury. Historical industrial activities produced and used a  
41    variety of chemicals including VOCs, PCBs, and radionuclides (primarily uranium, tritium and  
42    strontium-90), which remain present at low concentrations in groundwater on the Hermes site  
43    and in the surrounding area. The DOE continues to monitor surface water and groundwater at  
44    various locations (DOE 2021-TN7913 | Figure 2.2, DOE 2021-TN7915 | Figure 3.24) within the

1      Hermes site area. The applicant does not intend to use onsite groundwater for construction,  
2      operation, or decommissioning (Kairos 2021-TN7880 | Sec 3.4.2.2).

3      For groundwater monitoring, the applicant will implement a quarterly radiological environmental  
4      monitoring plan consistent with NUREG-1301 (TN5758, TN7879 | Sec 11.1.7), complementing  
5      existing DOE sampling locations (TN7913, Figure 2.2 and TN7915, Figure 3.24) and monitoring  
6      obligations within the Hermes site area (Kairos 2021-TN7880 | Sec 4.8.3.2, TN7902). Neither  
7      the surficial nor bedrock aquifers at or near the Hermes site are classified as EPA sole source  
8      aquifers (EAP 2022-TN7916). The applicant stated that there would be no liquid effluent  
9      release pathways and consequently no detectable radionuclides released to surface waters  
10     (Kairos 2021-TN7880 | Sec 4.8.3.2). Therefore, surface water monitoring is not included in the  
11     applicant's radiological environmental monitoring plan.

12     Within Roane County, over 70 percent of the water supply is derived from surface water sources  
13     and the remainder from groundwater. Within the area of the Hermes site, potable water is  
14     supplied through the City of Oak Ridge Public Works Department by way of Melton Hill Lake.  
15     The applicant estimated the total daily demand for water to be approximately 49 gallons per  
16     minute (gpm) or 0.07 million gallons per day (mgd), with an infrequent fire suppression system  
17     requirement of 3,170 gpm (4.56 mgd) and an associated makeup requirement of 793 gpm  
18     (1.14 mgd) within eight hours (Kairos 2021-TN7880 | Sec 3.4.2.3) for a static total storage  
19     requirement of approximately 380,400 gallons (gal). (Kairos 2022-TN7902). The applicant  
20     would not directly use any raw surface water or groundwater (Kairos 2021-TN7880 | Sec 4.4.2).  
21     Formerly owned and operated by the DOE, the City of Oak Ridge has owned and operated the  
22     current water supply treatment plant since 2000 (Kairos 2021-TN7880 | Sec 4.4.2.1). The City  
23     of Oak Ridge plans to design and construct a new ultrafiltration membrane drinking water  
24     treatment plant to replace the several decades old conventional treatment plant, which is  
25     currently at capacity and beyond its useful life (EAP 2022-TN7916). The new plant will have the  
26     capacity to treat up to 16 mgd with completion and operation targeted to occur in 2025 (Kairos  
27     2021-TN7880 | Sec 3.4.2.1).

28     The Clinch River Industrial Park, the East Tennessee Technology Park, Horizon Center, and  
29     Rarity Ridge are served by the Rarity Ridge Wastewater Treatment Plant (WWTP), which has a  
30     wastewater treatment capacity of 0.6 mgd. Correspondingly, the applicant's proposed facilities  
31     within the East Tennessee Technology Park would be served by the Rarity Ridge WWTP.  
32     Currently the Rarity Ridge WWTP operates at peak (0.6 mgd) capacity during wet weather;  
33     however, the applicant stated that the City of Oak Ridge is currently working toward reducing  
34     inflow and infiltration coming into the WWTP (Kairos 2021-TN7880 | Sec 5.2). To date, the Oak  
35     Ridge Public Works Department has continued to make progress in reducing unnecessary  
36     inflow and treatment of rainfall runoff, thereby preserving the capacities of the existing WWTPs  
37     (NRC 2022-TN7955). Under a capacity, management, operation, and maintenance program for  
38     upkeep of sewer collection systems, the City of Oak Ridge plans to evaluate the timing of a  
39     Rarity Ridge WWTP expansion during fiscal year 2022 (City of Oak Ridge 2021-TN7917).

40     Given the planned expansion of the City of Oak Ridge's municipal water supply and wastewater  
41     treatment improvement program, municipal capacities would be sufficient for the anticipated  
42     water supply and water treatment requirements for the planned facilities. The NRC staff  
43     confirmed that the Oak Ridge Public Works Department has sufficient capacity to meet the  
44     water supply and wastewater treatment requirements of the proposed facility (NRC 2022-  
45     TN7955).

1    3.3.2.2    *Environmental Consequences of Construction*

2    Building the proposed facilities would involve temporary disturbance of approximately 138 ac on  
3    the Hermes site (Kairos 2021-TN7880 | Sec 4.5.1.3). The applicant would use approximately  
4    30 ac of the previously developed land for the proposed plant and associated facilities. The  
5    applicant anticipates an excavation depth of approximately 30 ft below a finished grade of 765 ft  
6    for the Reactor Building and the Auxiliary Systems Building. Other ancillary buildings would be  
7    excavated to an estimated depth of approximately 10 ft below grade (Kairos 2021-TN7880 | Sec  
8    4.3.2). The water table is approximately 6 to 8 ft below the anticipated approximate finished  
9    grade of 765 ft.

10   Groundwater would not be used during construction activities but may be extracted as a  
11   consequence of dewatering for the Reactor Building and the Auxiliary Systems Building  
12   excavation because these excavations are anticipated to be up to 30 ft deep (Kairos 2021-  
13   TN7880 | Sec 4.3.2). Using site-specific parameters derived from field studies, the applicant  
14   has estimated a total dewatering upper bound of approximately 2.2 million gal over an  
15   approximately 30-day foundation construction period (Kairos 2022-TN7902). Because the  
16   Hermes site is hydraulically bounded by Poplar Creek and the Clinch River arm of the Watts Bar  
17   Reservoir, the NRC staff determined that the influence of dewatering would be limited to the  
18   shallow groundwater system on the site and that the effects would be negligible at offsite  
19   locations. Because of past industrial activities at the Hermes site, the quit claim deed includes a  
20   site prohibition for use of groundwater in any way unless such use is approved by the DOE,  
21   EPA, and TDEC (Kairos 2021-TN7880 | Sec 4.4.1.1). The dewatering action would have  
22   minimal effects on the surrounding surface water quality because of BMPs, the TDEC  
23   stormwater discharge permit restrictions, and the regulatory oversight of extracted water as  
24   managed by the DOE, EPA, and the TDEC. The storm-water discharge permit would prescribe  
25   the amount of any surface water discharge and establish the parameters to minimize impacts on  
26   the surrounding waters (Kairos 2021-TN7880 | Sec 4.4.1.1) in compliance with EPA, TDEC, and  
27   DOE requirements (TN7902).

28   In ER Table 1.3-1, the applicant summarized the Federal, State and local regulations and  
29   permits applicable to surface water hydrology and quality applicable to construction, operation  
30   and decommissioning for the project (Kairos 2021-TN7880 | Sec 4.4.1.1). Although the Hermes  
31   site will be temporarily disturbed by construction activities, there are no distinguishable surface  
32   water features on the site that could be affected. There are no discernible surface water  
33   features draining the Hermes site and the majority of rainfall runoff flows directly to Poplar Creek  
34   and to the K-901-A Holding Pond (Kairos 2021-TN7880 | Sec 3.5.2). No direct use of raw  
35   surface water or groundwater would be used during the Hermes site construction. Adherence to  
36   DOE, EPA, and TDEC quit claim deed requirements, BMPs, and implementation of a SWPP  
37   and associated permits during construction would result in minimal effects on the groundwater  
38   and surface water quality surrounding the Hermes site. Based on its review of the ER, the NRC  
39   staff expects that building the proposed facilities would have at most minimal impacts on water  
40   resources on or near the Hermes site.

41   3.3.2.3    *Environmental Consequences of Operation*

42   Impacts on water resources from the proposed four-year period of operation would be similar to  
43   those described above for the period of construction. As described by the applicant,  
44   groundwater withdrawal and dewatering discharge during operation would not be required  
45   (Kairos 2021-TN7880 | Sec 4.4.1.1). No raw surface water or groundwater would be used for  
46   Hermes site operation and the City of Oak Ridge would supply the site with potable water.

1 Based on an estimated daily water use of approximately 48 gpm (0.07 mgd) for the plant and  
2 the City of Oak Ridge's pending construction and completion of a new water treatment plant  
3 with a capacity of 16 mgd, the proposed facility would have sufficient potable water supply.  
4 Periodic supply to the fire suppression system would include an initial fill and occasional  
5 makeup water refill (Kairos 2021-TN7880 | Sec 3.4.2.3). The City of Oak Ridge municipal  
6 supply system would provide for the initial and any required subsequent refills of the fire  
7 suppression storage system. With the facility's water supply provided by the City of Oak Ridge,  
8 and demineralized water trucked into the facility, the applicant would have no need for a raw  
9 surface water supply or surface water cooling intake (Kairos 2021-TN7880 | Sec 6.3.3).  
10 Consistent with other facilities within the East Tennessee Technology Park, wastewater service  
11 for the proposed facility would be provided by the City of Oak Ridge (NRC 2022-TN7955 |  
12 personal communication) and the applicant anticipates no direct discharge to surface water  
13 bodies (Kairos 2021-TN7880 | Sec 6.3.3). Stormwater BMPs combined with the required  
14 permitting for stormwater management, including initial discharge to an onsite stormwater pond  
15 and later release to Poplar Creek, would minimize the effects of Hermes site runoff. Therefore,  
16 the applicant does not propose any mitigation (Kairos 2021-TN7880 | Sec 4.4.1), and the NRC  
17 staff finds that none is necessary to minimize adverse water resource impacts based on the  
18 NRC staff's evaluation of this CP application. At the OL stage, NRC staff will review the  
19 application for any new and significant information that might alter the staff's conclusions made  
20 about this CP application.

21     3.3.2.4   *Environmental Consequences of Decommissioning*

22 The applicant noted that no decommissioning activities would occur in the surface water bodies  
23 of Poplar Creek or the Clinch River (Kairos 2021-TN7880 | Sec 4.4.1). As stated by the  
24 applicant, an SWPP similar to that required by construction, including a sediment and erosional  
25 control plan, would be required for decommissioning and the existing stormwater retention pond  
26 used during operation could be used for decommissioning (Kairos 2021-TN7880 | Sec 4.4.1).  
27 Although no groundwater would be used onsite, dewatering may be needed to complete  
28 removal of building foundations. As previously discussed, the extraction, consumption, and  
29 exposure to or the use of groundwater on the Hermes site requires approval from the DOE,  
30 EPA, and the TDEC (Kairos 2021-TN7880 | Sec 4.4.1). Depending on the duration and volume  
31 of groundwater extracted, minor impacts could be associated with discharges of the extracted  
32 groundwater to Poplar Creek; however, the extraction of groundwater would be managed in  
33 compliance with the DOE, EPA, and TDEC permitting requirements (TN7902). The NRC staff  
34 expects that decommissioning impacts on water resources would be bounded by the analyses  
35 in the decommissioning generic EIS (NRC 2002-TN7254 | Supplement 1) and the stormwater  
36 discharge permit requirements for discharge and quality of stormwater. The applicant does not  
37 propose any mitigation (Kairos 2021-TN7880 | Sec 4.4.1), and the NRC staff finds at this time  
38 that none is necessary to minimize adverse water resource impacts based on the evaluation of  
39 this CP application.

40     3.3.2.5   *Cumulative Impacts*

41 Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
42 could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
43 TN7880). Key past and present actions affecting water resources in the Hermes site area  
44 include the Federal nuclear and energy development facilities on the Oak Ridge Reservation  
45 such as the Y-12 Plant and ORNL; the residential and commercial areas in the City of Oak  
46 Ridge; multiple energy and industrial park projects; a planned General Aviation Airport 1.1 mi  
47 east of the Hermes site; a large housing development, (the Preserve at Clinch River), currently

1 undergoing construction approximately 2 mi west of the site; and other land use features of a  
2 suburban or semi-rural landscape. Construction, operation, and decommissioning actions for  
3 the proposed Hermes facilities or the planned Atlas facility adjacent to the Hermes site would  
4 not directly use groundwater or surface water. The Atlas facility is anticipated to use the same  
5 BMPs in compliance with Federal, State and local environmental laws, rules, regulations and  
6 statutes in coordination with the DOE. Therefore, the staff finds that the proposed action would  
7 implement appropriate stormwater management, spill prevention and response plans, an  
8 environmental monitoring program, and comply with stormwater permit requirements including  
9 the SWPP. Further, because the proposed action would be built and operated within an existing  
10 industrial park, the NRC staff finds it would not contribute to the adverse cumulative impacts on  
11 groundwater or surface water resources in Poplar Creek or in the Clinch River arm of the Watts  
12 Bar Reservoir.

13     3.3.2.6     *Conclusions*

14     The NRC staff concludes that the potential direct, indirect, and cumulative water resource  
15     impacts of the proposed action would be SMALL. This conclusion is based primarily on the fact  
16     that the water demands of the Hermes facilities would be met through municipal or commercial  
17     suppliers, there would be no direct groundwater or surface or water use, and that disturbances  
18     to groundwater from potential dewatering would be temporary and localized to the hydrologically  
19     isolated onsite shallow aquifer in accordance with BMPs and the required permits. The NRC  
20     staff recognizes that there could be minor impacts on the municipal water supply due to the  
21     relatively small increased daily demand of the facility (0.07 mgd); however, the planned  
22     increases in the City of Oak Ridge's municipal water supply and existing wastewater treatment  
23     capacity would be adequate to service the facility and the future water treatment plant would  
24     create additional reserve capacity. Given the municipal water supply source and the low water  
25     demands of the Hermes project, the proposed facilities would result in minimal effects on  
26     aquifers and surface water bodies.

27     3.4     Ecological Resources

28     3.4.1     Affected Environment

29     The site is situated in the Southern Limestone/Dolomite Valley and Low Rolling Hills ecoregion,  
30     which is characterized by limestone and cherty dolomite with rolling ridges and valleys with soils  
31     of varying productivity (Kairos 2021-TN7880 | Sec 3.5.1). Section 3.5.7.1 of the ER describes  
32     terrestrial habitats on the site (Kairos 2021-TN7880). The 185 ac site consists of 88 ac of  
33     developed land, 72 ac of herbaceous grassland, 19 ac of deciduous forest, and 6 ac of mixed  
34     evergreen/deciduous forest. As seen in Figure 3.1-1 of the ER (Kairos 2021-TN7880), the  
35     developed land and herbaceous grassland correspond mostly to lands previously occupied by  
36     former DOE Buildings K-31 and K-33, while the forested land occurs only in perimeter areas on  
37     riparian lands separating the previously developed lands from Poplar Creek. The ER notes that  
38     the only wetland on the site occurs in the forested perimeter lands adjoining Poplar Creek, and  
39     that none occurs in the previously disturbed lands that formerly accommodated DOE Buildings  
40     K-31 and K-33 (Kairos 2021-TN7880 | Sec 3.5.6 and Figure 3.5-2). The NRC staff accessed  
41     the online National Wetlands Inventory mapper maintained by the U.S. Fish and Wildlife Service  
42     (FWS) on March 9, 2022; and the mapper showed only one wetland on or adjacent to the site,  
43     the channel of Poplar Creek, but it did not show the wetlands mentioned in the ER (FWS 2022-  
44     TN5327). There are no aquatic habitats on the site, although the site adjoins Poplar Creek, a  
45     tributary to the Clinch River arm of Watts Bar Reservoir (Kairos 2021-TN7880 | Sec 3.5.5).

1 A 17 ac holding pond (K-901-A Holding Pond) is approximately 700 ft west-southwest of the site  
2 (Kairos 2021-TN7880 | Sec 3.5.5.3).

3 Given its industrial history, the site can be expected to provide poor quality ecological habitat  
4 (Kairos 2021-TN7880 | Sec 3.5.2). The developed and grassland areas on the site consist of  
5 grasses and forbs typical of previously disturbed soils, as characterized in Section 3.5.7.1 of the  
6 ER (Kairos 2021-TN7880). Terrestrial wildlife expected to occur on the site—including  
7 mammals, birds, reptiles, and amphibians—is described in Section 3.5.7.2 of the ER (Kairos  
8 2021-TN7880). Species of wildlife expected in the previously developed lands formerly  
9 occupied by DOE Buildings K-31 and K-33 are the regionally abundant species typical of open  
10 field habitats. The applicant characterizes the aquatic biota of the Clinch River arm of the Watts  
11 Bar Reservoir; including fish, benthic macroinvertebrates, and plankton; in Section 3.5.5.1 of the  
12 ER. Because the reach of Poplar Creek adjoining the site is influenced by water levels in the  
13 reservoir, the applicant posits in Section 3.5.5.2 of the ER that the aquatic habitat in that part of  
14 the creek can be expected to be similar. Due to the history of disturbance on the site and  
15 surrounding areas, and in the adjoining reach of Poplar Creek, the terrestrial and aquatic biota  
16 in the area has been substantially influenced by invasive species (Kairos 2021-TN7880 | Sec  
17 3.5.8). The applicant also describes aquatic biota in the K-901 Holding Pond in Section 3.5.5.3  
18 of the ER, but the Hermes project is unlikely to affect this pond, which is located approximately  
19 700 ft away from the site. The applicant summarizes the history of ecological monitoring by  
20 DOE under the ORR Biological Monitoring and Abatement Program in Section 3.5.10 of the ER.

21 Section 3.5.11 of the ER identifies and characterizes species protected under Federal and State  
22 regulations based on a review of databases maintained by the FWS and TDEC (Kairos 2021-  
23 TN7880). Species addressed include those listed as threatened or endangered under the  
24 Federal Endangered Species Act (ESA) (TN1010) (or designated with another special Federal  
25 status), species designated with a State protected status, migratory birds protected under the  
26 Migratory Bird Treaty Act, and eagles protected under the Bald and Golden Eagle Protection  
27 Act. Each species with a Federal or State protected status is listed in Table 3.5-2 of the ER  
28 (Kairos 2021-TN7880). The applicant accessed the FWS Information for Planning and  
29 Consultation (IPaC) database on May 24, 2021, to identify Federally listed species and habitats  
30 for purposes of preparing the ER. The NRC staff accessed the database independently on  
31 February 24, 2022, and received similar results. Both the applicant and NRC staff used the  
32 185 ac site as the action area for the IPaC search because the site is a large lot within an  
33 established industrial park (the Heritage Center within the East Tennessee Technology Park).  
34 The action area therefore encompasses the lands previously distributed by former DOE  
35 operations, but for conservatism also includes the slivers of riparian forested land on the site  
36 bordering Poplar Creek that might be affected by project-related noise. Neither the applicant  
37 nor the NRC staff extended the action area beyond the site boundary because it would then  
38 encompass areas distinctly different from those actually affected by the Hermes project.

39 The IPaC searches indicate that four Federally listed endangered species, four Federally listed  
40 threatened species, and one Federal candidate species could potentially occur at the site. The  
41 endangered species include two mammal species, the gray bat (*Myotis grisescens*) and Indiana  
42 bat (*M. sodalis*); and two freshwater clam species, the finerayed pigtoe (*Fusconaia cuneolus*)  
43 and shiny pigtoe (*F. cor*). The threatened species include one bat species, the northern long-  
44 eared bat (*M. septentrionalis*); one fish species, the spotfin chub (*Erimonax monachus*); and two  
45 plant species, the Virginia spiraea (*Spiraea virginiana*) and white fringeless orchid (*Platanthera*  
46 *integerrimolia*).

1 A biological assessment (BA) recently completed for the nearby CRN site (NRC 2019-TN6136 |  
2 Appendix M), approximately 2 mi south of the Hermes site, addresses the gray bat, Indiana bat,  
3 and northern long-eared bat. For each of the three bat species, the BA characterizes the range,  
4 status and threats, life history, and baseline data from past field surveys in the region.  
5 According to the BA, gray bats hibernate in deep caves during the winter but disperse within the  
6 protection of forest canopy to a broader variety of caves during the rest of the year to form  
7 maternity colonies. Indiana and northern long-eared bats also hibernate in caves (the latter also  
8 in mines or human-made structures) and disperse to forested areas to form maternity roosts in  
9 trees. The BA reports the results of past field studies, including mist netting studies and  
10 acoustic studies, for the three bat species in the Oak Ridge area. Based on information in the  
11 BA, the NRC staff expects that each of the three bat species may potentially forage, and thus  
12 could be transiently present anywhere in the Oak Ridge area. However, the absence of trees or  
13 vegetation other than ruderal vegetation in the area where the Hermes facilities would be sited  
14 suggests that even transient presence in the affected area is unlikely. The 135 ac of land  
15 potentially subject to temporary or permanent disturbance for building, operating, and  
16 decommissioning the Hermes facilities contains trees and thus lacks any potential roost or  
17 maternity trees.

18 The NRC staff recognizes that the subject bat and plant species would be unlikely to occur  
19 anywhere in the action area other than in the forest and other riparian vegetation separating the  
20 project lands from Poplar Creek, and that the only part of the action area where the clam and  
21 fish species could occur is the channel of Poplar Creek. The searches did not indicate the  
22 presence of critical habitat identified under the ESA.

23 The NRC staff initiated its own informal consultation under ESA Section 7 through written  
24 correspondence with the FWS dated March 10, 2022 (NRC 2022-TN7918). The staff received  
25 an E-mail from FWS dated April 15, 2022 (FWS 2022-TN7956) requesting that NRC include in  
26 this draft EIS a biological evaluation addressing the potential impacts from the Hermes project  
27 to potentially affected resources covered by the Endangered Species Act. Table 3-4, together  
28 with information included in the subsections below, constitute the NRC staff's biological  
29 evaluation. The staff is presently working with FWS to close the consultation process.

### 30 **3.4.2 Environmental Consequences of Construction**

31 Building the proposed facilities would involve temporary disturbance of approximately 138 ac on  
32 the site, of which 58 ac consist of herbaceous grassland and the remainder consists of existing  
33 developed land (Kairos 2021-TN7880 | Table 4.5-1). As depicted in Figure 2.2-1 of the ER  
34 (Kairos 2021-TN7880), no naturally vegetated land would be disturbed, including the deciduous  
35 and mixed evergreen/deciduous forest on the site. Approximately 30 ac of the temporarily  
36 disturbed herbaceous grassland would be permanently converted to industrial land cover.  
37 Because all of the disturbed vegetation occupies previously disturbed soils, the disturbances  
38 would not further promote establishment of invasive species. The applicant plans to restore  
39 herbaceous grassland to the remaining temporarily disturbed land (Kairos 2021-TN7880 | Sec  
40 4.5.1.3). No wetlands or aquatic habitats would be disturbed (Kairos 2021-TN7880 | Sec  
41 4.5.1.2). The applicant proposes to manage stormwater on the site using BMPs as required by  
42 the TDEC (Kairos 2021-TN7880 | Sec 4.5.1.2). Common BMPs for managing stormwater  
43 runoff into aquatic habitats near construction sites include the use of silt fences, vegetative  
44 stabilization of exposed soils, and stormwater ponds. Because of the historical disturbance of  
45 the affected land and the lack of disturbance to forest and other natural vegetation, wetlands, or  
46 aquatic habitat, the NRC staff expects that effects on terrestrial wildlife habitats would be  
47 minimal.

1 Mobile terrestrial wildlife can be expected to avoid areas where construction equipment is in use  
2 (Kairos 2021-TN7880 | Sec 4.5.1.3). Less mobile wildlife could be injured or killed by  
3 equipment, but because of the low-quality of the affected habitat, any losses are unlikely to be  
4 ecologically substantial. Birds might be injured or killed by collision with tall structures or  
5 equipment such as construction cranes (Kairos 2021-TN7880 | Sec 4.5.1.3), but a recent  
6 literature review by the NRC staff indicates that bird collisions with structures at nuclear power  
7 sites are generally not substantive (NRC 2013-TN2654 | Sec 4.6.1.1). That review focused on  
8 structures such as natural draft cooling towers, communications towers, or electric transmission  
9 lines that are taller or pose a greater risk to birds than the structures proposed for the Hermes  
10 project. The proposed Hermes project would not include any cooling towers or transmission  
11 lines. The NRC staff also recognizes that vehicles using roads to access and traverse the site  
12 could injure or kill wildlife; but considering the low number of projected site workers and the  
13 already disturbed character of the habitats on the site and nearby portions of the East  
14 Tennessee Technology Park, vehicular collisions with wildlife would likely be too infrequent to  
15 noticeably affect regional populations. Overall, the NRC staff recognizes that the ecological  
16 quality of habitat affected by the Hermes project is low and that the potential effects on wildlife  
17 are likewise low.

18 The applicant indicated that excavation to build the Hermes reactor would necessitate  
19 temporary dewatering of the excavation pit (Kairos 2021-TN7880 | Sec 4.4.1.1.1). The  
20 applicant confirmed that the dewatering would involve no more than 2.2 million gal over a period  
21 of approximately 30 days (Kairos 2022-TN7902). The applicant confirmed that the dewatered  
22 groundwater would be transported offsite for disposal or would be treated onsite and returned to  
23 the groundwater in accordance with applicable EPA, DOE, and State of Tennessee  
24 requirements (TN7902). The dewatering could temporarily reduce water levels in wetlands in  
25 nearby forested riparian lands bordering Poplar Creek, but any effects would be temporary.  
26 These brief and temporary effects on water levels in the wetlands would be less severe than  
27 expected from short droughts that commonly occur as part of the natural hydroperiod of the  
28 wetlands. Because of the brevity of the effects, the functional characteristics and habitat quality  
29 of the affected wetlands are unlikely to be changed.

30 The applicant acknowledges that building the Hermes facilities would result in a localized,  
31 minor, and temporary increase in noise that may be noticeable to wildlife on or close to the site  
32 (Kairos 2021-TN7880 | Sec 4.5.2.3). The applicant describes most noise as being within 3 dbA  
33 of ambient noise 1 mi from the site (Kairos 2021-TN7880 | Table 4.2-3), but recognizes that  
34 temporary periods of greater noise would occur even at that distance when some construction  
35 equipment such as pile drivers are in use, or when multiple pieces of construction equipment  
36 are in use simultaneously (Kairos 2021-TN7880 | Sec 4.2.2). The NRC staff recognizes that  
37 wildlife using the fragments of forested habitat remaining within the East Tennessee Technology  
38 Park might experience occasional periods of elevated noise that could cause startle responses  
39 or cause wildlife to avoid some areas for brief periods of time. But the staff also recognizes that  
40 the habitat quality within the East Tennessee Technology Park, including within the remaining  
41 fragments of forested habitat within the East Tennessee Technology Park, is not of high-quality  
42 and that large areas of superior habitat are available outside of the East Tennessee Technology  
43 Park for displaced wildlife. Furthermore, the affected wildlife is likely already acclimated to  
44 noise from other ongoing industrial and urban activity within the East Tennessee Technology  
45 Park.

46 Although Federally and State-listed protected species are present in forested and other naturally  
47 vegetated lands and in water bodies near the site (Kairos 2021-TN7880 | Sec 4.5.2.1), no  
48 habitat potentially suitable for those species would be disturbed. All of the protected species

1 noted as occurring in Roane County in Table 3.5-2 of the ER (Kairos 2021-TN7880) require  
2 aquatic, wetland, or other naturally vegetated habitats that would not be disturbed by building  
3 the proposed new facilities. The applicant states that no Federally protected plant species has  
4 been observed on the site and that only one Federally listed species has a greater than low  
5 potential to occur on the site, the endangered Indiana bat; but the applicant explains that there  
6 are no trees of species favorable to the Indiana bat in the adjoining riparian lands along Poplar  
7 Creek (Kairos 2021-TN7880 | Sec 4.5.1.5).

8 Based on its review of the project, the NRC staff expects that building the proposed facilities  
9 may affect, but is not likely to adversely affect, certain species listed as threatened or  
10 endangered under the ESA (Table 3-4). Preparing the site and building the Hermes facilities  
11 would not disturb any trees, forest cover, or natural vegetation and therefore would have little  
12 potential to adversely affect the three Federally-listed bats or two listed plants identified in the  
13 IPaC searches. The three bat species all hibernate in caves and when dispersing from the  
14 caves move, roost, breed, and forage in forested and semi-forested areas, not in large,  
15 developed areas without trees (NRC 2019-TN6136 | Appendix M) such as the area where the  
16 Hermes facilities would be built and operated (see Table 3-4 for more information). Noise from  
17 building the Hermes facilities could be audible to bats transiently present while foraging in  
18 forested areas along Poplar Creek, but those thin fragments of habitat are unlikely to attract  
19 bats for extended time periods. The project would also have little potential to adversely affect  
20 the monarch butterfly, an insect species identified in the IPaC searches as a Federally listed  
21 candidate species that could potentially be transiently present in the area. Because the project  
22 would not withdraw or discharge cooling water or industrial process water (see Section 3.3 of  
23 this draft EIS) or disturb surface water or shoreline habitats, it would have no potential to  
24 adversely affect the two listed clam species or the listed fish species. As indicated above, the  
25 NRC staff initiated informal consultation under Section 7 of the ESA through written  
26 correspondence with the FWS dated March 10, 2022 (NRC 2022-TN7918). The NRC staff is  
27 working with FWS as appropriate to close the consultation process.

### 28 **3.4.3 Environmental Consequences of Operation**

29 Impacts on ecological resources from the proposed 4 years of operation of the completed  
30 facilities would be less than those described above for the construction period. Only about  
31 30 ac of former terrestrial habitat, all presently supporting herbaceous grassland within the  
32 former footprint of DOE Building K-33, would remain occupied by the Hermes facilities during  
33 the operational period. No additional land, and hence no additional habitat, would be physically  
34 disturbed by operation. Noise generation would affect wildlife in the same way as described  
35 above for construction but would not include brief periods of higher noise generation using  
36 exceptionally noisy equipment such as pile drivers. The potential for bird collisions with  
37 structures would be as described above for construction. The applicant would use occasional  
38 applications of herbicides in developed areas on the site for lawn maintenance and to control  
39 weeds (Kairos 2021-TN7880 | Sec 4.5.2.3). Use of properly labeled herbicides in developed  
40 areas in accordance with instructions on the label is unlikely to adversely affect nearby habitats.  
41 The applicant does not propose any mitigation measures (Kairos 2021-TN7880 | Sec 4.5.2.5),  
42 and the NRC staff expects the effects from operation to be minimal, so no mitigation would be  
43 necessary to minimize adverse ecological impacts. Because operations would not disturb  
44 natural terrestrial or aquatic habitats and would have little potential to affect wildlife through  
45 noise or collisions, they would have little potential to adversely affect threatened or endangered  
46 species.

1    **3.4.4    Environmental Consequences of Decommissioning**

2    The applicant reports that ecological impacts from decommissioning would be similar to those  
3    from construction (Kairos 2021-TN7880 | Sec 4.5.3). The NRC staff expects that land  
4    disturbance during decommissioning would take place mostly within already developed areas  
5    within the 30 ac area permanently occupied by the proposed new facilities but may require  
6    exterior storage of debris or equipment in adjoining exterior areas of previously disturbed soils  
7    on the 185 ac site. The NRC staff also expects that noise generated during decommissioning  
8    may involve intermittent generation of higher noise levels than during operation as buildings and  
9    structures are demolished, with effects on wildlife as described above for construction.  
10   Additionally, the NRC staff expects that decommissioning impacts on ecological resources on  
11   the site would be bounded by the analyses in the decommissioning generic EIS (NRC 2002-  
12   TN7254 | Supplement 1). Although the generic conclusion does not extend to offsite ecological  
13   impacts from decommissioning, the offsite impacts would be minimal for the reasons indicated  
14   above. The applicant does not propose any mitigation measures (Kairos 2021-TN7880 | Sec  
15   4.5.3), and the NRC staff feels that the effects from operations would be so minimal that no  
16   mitigation is necessary to minimize adverse ecological impacts. Decommissioning would have  
17   no more potential than construction to affect threatened or endangered species.

18   **3.4.5    Cumulative Impacts**

19   Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
20   could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
21   TN7880). Key past and present actions affecting ecological resources in the affected area  
22   include the Federal nuclear and energy development facilities on the ORR such as the Y-12  
23   Plant, ORNL, and other energy research facilities; the residential and commercial areas in the  
24   original townsite of the City of Oak Ridge; multiple energy and industrial park projects; a large  
25   housing development presently undergoing construction approximately 2 mi west of the site  
26   (called “the Preserve at Clinch River”); and other land use features of a suburban or semi-rural  
27   landscape. Key reasonably foreseeable proposed projects in the region include the Horizon  
28   Center on former ORR forest land approximately 2.3 mi northeast of the site (for which DOE has  
29   excessed land to the City of Oak Ridge and roadways have been built), anticipated industrial  
30   development of other previously developed land in the Heritage Center, and a proposed general  
31   aviation airport approximately 1.1 mi south and east of the site. If the applicant were to build the  
32   Atlas facility on the site, it would only affect the herbaceous grassland and developed land  
33   formerly disturbed by DOE Buildings K-31 and K-33 and therefore would not further contribute  
34   to loss or degradation of ecological habitats. Because of the close proximity of the Hermes and  
35   Atlas facilities, the addition of the Atlas facility would not likely alter the patterns of noise and  
36   physical obstructions experienced by wildlife.

37   Past and present urban and industrial development in the surrounding area has already resulted  
38   in a landscape of fragmented areas of forest and other terrestrial habitats. The proposed action  
39   would not further contribute to this fragmentation because it would be sited entirely within an  
40   existing developed area. The new facilities, especially the proposed airport (DOE 2016-  
41   TN7903), would contribute noise, artificial light, and wildlife hazards to some natural habitats to  
42   the south of the site but would not result in substantial decreases in the overall quality of nearby  
43   habitats. Building the airport would also result in the loss of approximately 132 ac of forested,  
44   riparian, shrub, and grassy areas, but DOE notes that the losses would constitute only a small  
45   percentage of similar habitats in the surrounding area and would affect mostly areas already  
46   influenced by development in the East Tennessee Technology Park. Because the proposed  
47   action would not involve physical disturbance of aquatic, wetland, or riparian habitats and not

1 involve withdrawals or discharges of water to aquatic habitats, it would not cumulatively  
2 contribute to degradation of aquatic habitats in Poplar Creek, the Clinch River arm of the Watts  
3 Bar Reservoir, or other water bodies in the area.

4 **3.4.6 Conclusions**

5 The NRC staff concludes that the potential direct, indirect, and cumulative ecological impacts of  
6 the proposed action would be SMALL. This conclusion is based primarily on the proposed  
7 action not physically disturbing aquatic, shoreline, or wetland habitats or natural terrestrial  
8 vegetation; the location of the site within an existing industrial park; and disturbances being  
9 limited to herbaceous grassland in previously disturbed industrial lands of low value as wildlife  
10 habitat. Reuse of former industrial land within an existing industrial park setting provides the  
11 economic benefits of the test reactor without requiring the disturbance of sensitive terrestrial or  
12 aquatic habitats that have not been previously disturbed. The staff recognizes that there could  
13 be minor effects from noise and lighting on terrestrial wildlife in habitats elsewhere surrounding  
14 the site, but the affected habitats are of low quality because of their proximity to other industrial  
15 activity and the affected wildlife can be expected to acclimate to the noise and lighting  
16 conditions. In particular, the staff recognizes the anticipated effects on surrounding habitats  
17 from future construction and operation of a new regional airport but does not expect the  
18 proposed action to substantially contribute to those effects. The staff recognizes that because  
19 no naturally vegetated areas would be disturbed, no special maintenance or conservation  
20 practices or mitigation measures (beyond BMPs typically employed for soil erosion and  
21 sediment control and for stormwater management) would be necessary to protect ecological  
22 resources.

23 Table 3-4 below presents the NRC staff's biological evaluation, prepared for review by the FWS  
24 under Section 7 of the ESA, of the possible effects of the Hermes project on Federally listed  
25 species potentially occurring in an action area consisting of the 185 ac Hermes site. For  
26 conservatism, the action area for the biological evaluation encompasses the entire site,  
27 including strips of riparian forest on the site that would not be physically disturbed by the project.  
28 All project work would be confined to lands previously disturbed by former DOE Buildings K-31  
29 and K-33 and currently being used for exterior industrial storage or herbaceous grasslands  
30 planted to stabilize previously disturbed soils. The NRC staff used the same conclusion  
31 terminology used by the FWS when responding to consultation requests under Section 7 of the  
32 ESA. The NRC staff concluded that the Hermes project may affect, but is not likely to adversely  
33 affect, or would have no effect, on each of the species considered.

34 **Table 3-4 Biological Evaluation of Federally Listed Species from Proposed Kairos  
35 Hermes Project**

Species	Federal Status	NRC Staff Evaluation	Conclusion
Gray bat ( <i>Myotis griseescens</i> )	Endangered	Baseline information: Flying mammal. Hibernates and breeds in caves, such as those that occur in undeveloped lands in the karst landscape located in the Oak Ridge area (NRC 2019-TN6136   Sec M.6.1.1). Moves and forages under forest cover (NRC 2019-TN6136   Sec M.6.1.1). Factors contributing to population declines include human disturbance of the hibernacula, flooding, and use of pesticides (NRC 2019-	May affect, but not likely to adversely affect (MA-NLAA)

Species	Federal Status	NRC Staff Evaluation	Conclusion
Indiana bat ( <i>M. soldalis</i> )	Endangered	<p>TN6136   Sec M.6.1.1). May be susceptible to white nose disease, a fatal fungal disease that infects hibernating bats (NRC 2019-TN6136   Sec M.6.1.1) and observed through frequent mist net and acoustic study-based observations conducted in Oak Ridge area from 2000–2015 (NRC 2019-TN6136   Sec M.6.1.1).</p> <p>Impacts: May forage transiently in riparian forest along Poplar Creek. Unlikely to enter lands where the Hermes facilities would be built, operated, and decommissioned, because those lands are not currently forested (or contain trees) and would not be forested or contain trees for the duration of the Hermes life cycle. Bats are expected to avoid areas of human activity, so the potential for injuries is minimal.</p>	MA-NLAA
Fine-rayed pigtoe ( <i>Fusconaia cuneolus</i> )	Endangered	<p>Baseline information: Flying mammal. Hibernates in caves and mines and forms maternity roosts in mature trees over 5-in diameter at breast height, especially trees with exfoliating barks (NRC 2019-TN6136   Sec M.6.1.2). Roosts and forages in forested or semi-forested areas (NRC 2019-TN6136   Sec M.6.1.2). Threats include disturbance to the hibernacula, loss and fragmentation of forested swarming and staging habitat, chemical contaminants, collision with wind turbines, and white nose disease (NRC 2019-TN6136   Sec M.6.1.2). Closest known maternity roost in Blount County, TN, is roughly 30 mi away (NRC 2019-TN6136   Sec M.6.1.2). One or more individuals were detected acoustically in forested areas at CRN site in 2013, but maternal roosting is not suspected (NRC 2019-TN6136   Sec M.6.1.2).</p> <p>Impacts: May forage transiently in the riparian forest along Poplar Creek. Expected to avoid lands where the Hermes project would be built, which presently contain only ruderal vegetation of no foraging value.</p>	MA-NLAA

<b>Species</b>	<b>Federal Status</b>	<b>NRC Staff Evaluation</b>	<b>Conclusion</b>
Shiny pigtoe ( <i>F. cor</i> )	Endangered	<p>Impoundments such as Poplar Creek, adjacent to the Hermes site.</p> <p>Impacts: Hermes project would not involve physical disturbances of aquatic or riparian habitats. Water demands would be met by municipal or commercial suppliers. BMPs to control sedimentation and runoff. Stormwater on the Hermes site would be managed by BMPs throughout the project life cycle.</p>	MA-NLAA
Northern long-eared bat ( <i>M. septentrionalis</i> )	Threatened	<p>Baseline information: Freshwater mollusk. Prefer substrate in streams with running water. Unlikely to thrive in stream channels influenced by impoundments such as that of Poplar Creek, adjacent to the Hermes site.</p> <p>Impacts: Hermes project would not involve physical disturbances of aquatic or riparian habitats. Water demands would be met by municipal or commercial suppliers. BMPs to control sedimentation and runoff. Stormwater on the Hermes site would be managed by BMPs throughout the project life cycle.</p>	MA-NLAA
Spotfin chub ( <i>Erimonax monachus</i> )	Threatened	<p>Baseline information: Winged mammal. Hibernates in caves, mines, and human-made structures and forms maternity roosts in trees with exfoliating barks or holes, or that are dead (NRC 2019-TN6136   Sec M.6.1.3). Roosts and forages in forested or semi-forested areas (NRC 2019-TN6136   Sec M.6.1.3). Prefers to roost in interior of late successional forests (NRC 2019-TN6136   Sec M.6.1.3). Listed as threatened in 2015 due to the effects of white nose disease (NRC 2019-TN6136   Sec M.6.1.3). Detected acoustically in forested areas at the CRN site in 2013, but maternal roosting is not suspected (NRC 2019-TN6136   Sec M.6.1.3).</p> <p>Impacts: May forage transiently in the riparian forest along the Poplar Creek. Expected to avoid lands where the Hermes project would be built, which currently contain only ruderal vegetation of no foraging value.</p>	MA-NLAA

<b>Species</b>	<b>Federal Status</b>	<b>NRC Staff Evaluation</b>	<b>Conclusion</b>
		<p>channels such as that of Poplar Creek adjacent to the Hermes site.</p> <p>Impacts: Hermes project would not involve physical disturbances of aquatic or riparian habitats. Water demands would be met by municipal or commercial suppliers. Stormwater managed by BMPs. BMPs to control sedimentation and runoff. Stormwater on the Hermes site would be managed by BMPs throughout the project life cycle.</p>	
Virginia spiraea ( <i>Spiraea virginiana</i> )	Threatened	<p>Baseline information: Shrub. Prefers stream bars and ledges (Kairos 2021-TN7880   Table 3.5-2). May occur in riparian forested lands along the Poplar Creek.</p> <p>Impacts: Physical disturbance for the Hermes project would be limited to soils previously disturbed for past industrial development. Plants not affected by noise. BMPs to control sedimentation and runoff. Stormwater on the Hermes site would be managed by BMPs throughout the project life cycle.</p>	MA-NLAA
White fringed orchid ( <i>Platanthera integrilabia</i> )	Threatened	<p>Baseline information: Herbaceous wildflower of acidic seeps and stream heads (Kairos 2021-TN7880   Table 3.5-2). May occur in riparian forested lands along the Poplar Creek.</p> <p>Impacts: Physical disturbance for the Hermes project would be limited to soils previously disturbed for past industrial development. Plants not affected by noise. BMPs to control sedimentation and runoff. Stormwater on the Hermes site would be managed by BMPs throughout the project life cycle.</p>	MA-NLAA

1 Key: NRC = U.S. Nuclear Regulatory Commission; MA-NLAA = may affect, but is not likely to adversely affect.

- 2 • Species identified through IPaC searches conducted by the applicant in May 2021 and the NRC staff in February  
3 2022, for an action area encompassing the entire 185 ac Hermes site.
- 4 • Conclusions follow terminology used by the FWS when providing consultations under Section 7 of the ESA.
- 5 • Conclusions are inclusive for the Hermes project for construction, operation, decommissioning, and cumulative  
6 effects, based on the information available at the time of the NRC staff's environmental review of the CP.

1    **3.5    Historic and Cultural Resources**

2    **3.5.1    Affected Environment**

3    Historic and cultural resources refer to archaeological sites, historic buildings, traditional cultural  
4    properties important to a living community,<sup>1</sup> shipwrecks, and other resources considered under  
5    the National Historic Preservation Act (54 U.S.C. § 300101 *et seq.* TN4157) of 1966, as  
6    amended. Historic and cultural resources determined to be significant include those that are  
7    eligible for inclusion in or formally listed on the National Register of Historic Places (NRHP).  
8    Section 106 of the NHPA requires Federal agencies to consider the effects of their undertakings  
9    on historic properties listed or eligible for listing on the NRHP. The procedures in 36 CFR Part  
10   800 (TN513) define how Federal agencies meet the statutory responsibilities of NHPA Section  
11   106. If historic and cultural resources are present, the eligibility of any historic properties for  
12   listing on the NRHP is determined through the application of the NRHP criteria in 36 CFR 60.4<sup>2</sup>  
13   (TN1682) in consultation with the State Historic Preservation Officer, American Indian Tribes  
14   (Tribes) that attach cultural and religious significance to historic properties, and other interested  
15   parties, pursuant to 36 CFR 800.2(c) (TN513).

16   In accordance with 36 CFR 800.8(c) (TN513), the NRC has initiated the NHPA Section 106  
17   consultation process and notified consulting parties, including the Advisory Council on Historic  
18   Preservation (AChP), the Tennessee Historical Commission (THC, i.e., the State Historic  
19   Preservation Officer), Tribes, and the National Park Service (NPS), of its intent to use the NEPA  
20   (42 U.S.C. § 4321 *et seq.* TN661) process to comply with Section 106 of the NHPA (see section  
21   on consultation below).

22   The current NRC undertaking is the issuance of a CP to Kairos that allows for the construction  
23   of the proposed Kairos Hermes project (see Section 1.1 of this EIS). If Kairos chooses to  
24   proceed with its proposed project, they will need to apply for, and receive, a separate OL from  
25   the NRC. This authorization would constitute a separate NRC undertaking and would require  
26   the NRC to prepare a supplement to the CP final EIS and complete a separate NHPA Section  
27   106 review and consultation.

28   The proposed project site is located within the East Tennessee Technology Park in the  
29   northwest quadrant of the ORR and is adjacent to the Clinch River arm of Watts Bar Reservoir  
30   in Roane County, Tennessee. The site comprises approximately 185 ac and is located on a  
31   parcel that previously housed Buildings K-31 and K-33, which were part of the K-25 complex

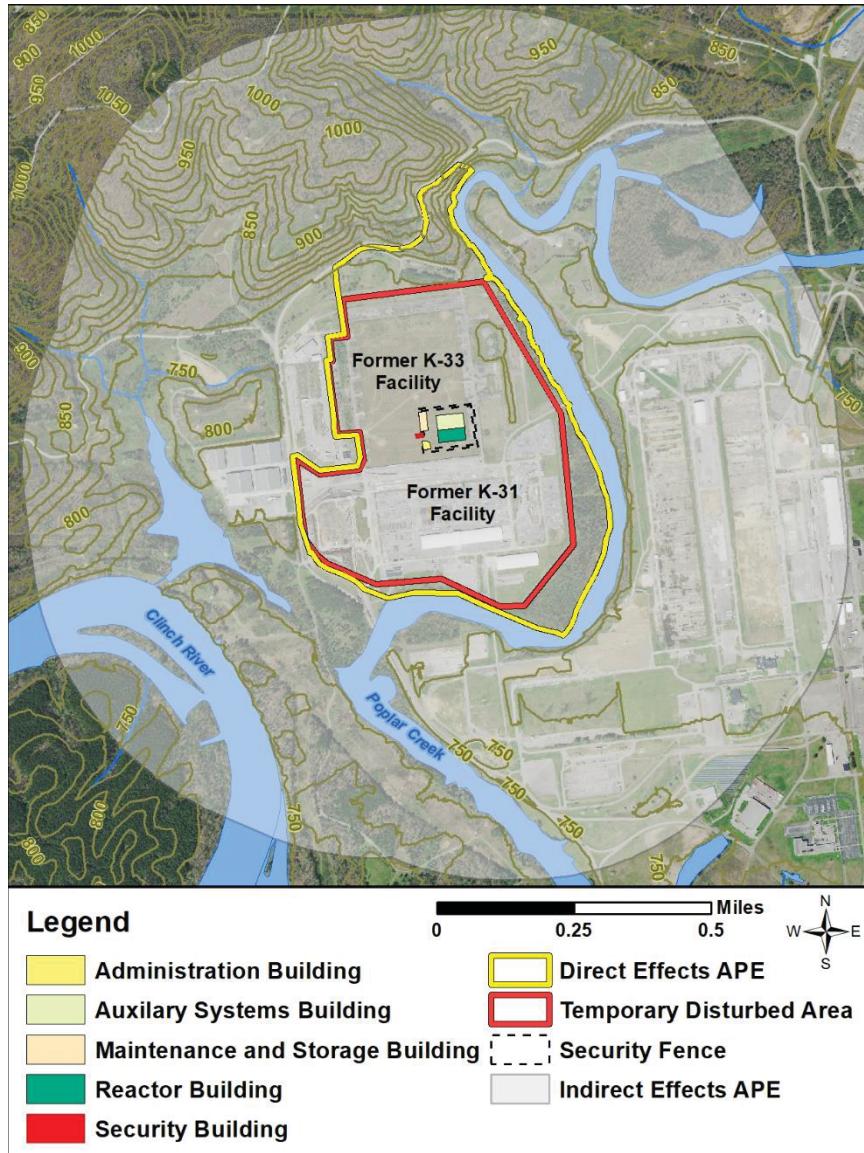
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<sup>1</sup> Traditional cultural properties are places that are important to a living community of people for maintaining its culture, including American Indian Tribes that attach cultural and religious significance to historic properties (Parker and King 1998-TN5840). It is important to note that American Indian Tribes also attach cultural and religious significance to other cultural resource types including pre-contact and historic-era archaeological sites

<sup>2</sup> The NRHP was established by the NHPA and is maintained by the National Park Service. The eligibility of cultural resources for listing on the NRHP are assessed based on four criteria:

- Criterion A: Associated with events that have made a significant contribution to broad patterns of our history; or Criterion B: Associated with the lives of persons significant in our past; or Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D: Have yielded, or are likely to yield, information important to prehistory and history.

1 and operated as the ORGDP. The NRC has determined that the area of potential effect (APE)<sup>1</sup>  
2 for the CP review includes the area at the Hermes reactor site and its immediate environs where  
3 the character and use of historic properties may be directly (i.e., physically) or indirectly (i.e.,  
4 visually or auditory) impacted by land-disturbing and building activities associated with the  
5 construction and operation of the proposed facility. Specifically, the NRC defined the direct-  
6 effects APE as the approximately 185 ac site (i.e., Kairos ownership site boundary) and the  
7 indirect-effects APE as the 0.5 mi area around the site (Figure 3-2).



8  
9 **Figure 3-2 Direct- and Indirect-Effects Area of Potential Effects at the Kairos Hermes**  
10 **Project**

<sup>1</sup> 36 CFR 800.16 (d) (TN513) defines the APE as “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties if they exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.”

1    3.5.1.1    *Cultural Background*

2    In April 2019, the NRC published NUREG-2226 (NRC 2019-TN6136), *Environmental Impact*  
3    *Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site* (hereafter referred to  
4    as the CRN EIS). Because of the timeliness of this draft EIS, and the close proximity (3.5 mi) of  
5    the CRN site to the proposed Kairos test reactor site, the NRC staff considers the cultural  
6    background description in the CRN final EIS (described in Section 2.7.1) to be relevant and  
7    accurate for the assessment of the proposed Hermes project and incorporated it into this EIS by  
8    reference.

9    As indicated in the referenced cultural background description, human occupation in east  
10   Tennessee spans thousands of years. The cultural background is derived from the pre-contact  
11   and historic overviews provided by Hunter et al. (Hunter et al. 2015-TN4971) and Barrett et al.  
12   (Barrett et al. 2011-TN4974, Barrett et al. 2011-TN4975).

13   Archaeologists divide the pre-contact period in east Tennessee into four distinct phases: Paleo-  
14   Indian, Archaic, Woodland, and Mississippian. Based on these divisions, archaeologists  
15   estimate that human occupation in this region began in at least 10,000 BC, if not earlier. The  
16   Paleo-Indian period is estimated to span from 10,000 BC to 8,000 BC (TN4971). The Paleo-  
17   Indian period was largely subsistence-based and archaeological finds identified in the region are  
18   limited to the recovery of a few Paleo-Indian Clovis-style projectile points, suggesting an  
19   infrequent pattern of resource utilization (TN4971).

20   The Archaic period is divided into three eras: Early (8,000 to 6,000 years BC), Middle (6,000 to  
21   3,000 BC), and Late (3,000 to 1,000 years BC). Settlement patterns associated with the Early  
22   Archaic Period are characterized by short-term resource use areas and base camps. The  
23   Middle Archaic Period reveals an increased diversity in artifact type as well as increased  
24   complexity in tool making. Settlement patterns are similar to the Early Archaic Period and are  
25   characterized by an increase in population and longer-term use of camp occupations. The Late  
26   Archaic Period is characterized by an increase in sedentary settlement patterns consisting of  
27   seasonal base camps and more short-term camps.

28   Two eras are associated with the Woodland Period in east Tennessee: Early (1,000 BC to  
29   200 BC) and Middle (200 BC to A.D. 900). Archaeological evidence suggests that rather than a  
30   transition to Late Woodland after the Middle Woodland Period, there is a transition to the  
31   Mississippian Period beginning in A.D. 900. The Early Woodland Period is characterized by  
32   mound building and widespread use of pottery, along with an increase in horticultural practices,  
33   including the cultivation of seeds, berries, and grains. Burial practices include internment in  
34   mounds and the development of more complex mortuary and ritual practices. Settlement  
35   patterns associated with the Early Woodland Period continue to include seasonally based  
36   camps. The Middle Woodland Period is characterized by an increase in sedentism and the  
37   development of a more complex social system. At the end of the Middle Woodland Period,  
38   there is an abrupt shift from base camp settlement to permanent villages, which correlates with  
39   an increased dependence on the cultivation of maize. The Mississippian Period (A.D. 900 to  
40   1540) is characterized by the increased reliance upon agriculture and the establishment of  
41   fortified villages, chiefdoms, and complex burial practices.

42   European explorers arrived in the vicinity of the proposed project area in 1540 as part of the  
43   DeSoto expedition and likely encountered the Coosa American Indian population (TN4971). By  
44   the 1700s, the Overhill Cherokee inhabited the area. With the arrival of fur traders in the 1700s,  
45   skirmishes between the French, British, and Indian groups increased in the area through the

1 early 1800s. In 1796, the State of Tennessee was formed. Between 1794 and 1838, as a result  
2 of three treaties with the Cherokee Indians and through forced removal at the time of the Trail of  
3 Tears, the Cherokee Indians were evicted from their ancestral homelands and required to  
4 relocate to Oklahoma (TN4971).

5 After the Depression, development in the Tennessee Valley, including the establishment of the  
6 TVA, led to a more-varied economic base in the region (TN4971). The first dam built by TVA  
7 commenced operation in 1936 with the opening of the Norris Dam (TN4975). The existence  
8 and location of the Norris Dam were contributing factors in the decision to locate "Site X" of the  
9 top-secret Manhattan Project in the Clinch River Valley area (Kairos 2021-TN7880 | Sec  
10 3.6.1). Other factors included the area's remoteness, rural nature, the ridge and valley  
11 topography, accessibility of the area via highway and rail, the low cost for acquiring property,  
12 and the prevalence of non-farm workers in the area (Kairos 2021-TN7880) | Sec 3.6.1, which  
13 referenced Cultural Resources Management Plan for DOE Oak Ridge. "Site X" eventually  
14 became the ORR and was part of the Manhattan Project (Kairos 2021-TN7880 | Sec 3.6.1).  
15 Land acquisition for the ORR began in 1942. Several agricultural communities in the area at  
16 that time were relocated to accommodate Manhattan Project related construction activities  
17 (Kairos 2021-TN7880 | Sec 3.6.1).

18 The proposed project is located at the site of the former NRHP-eligible K-31 and K-33 buildings,  
19 which were part of the K-25 complex and operated as the ORGD, which was constructed  
20 between 1943 and 1945 (Valk et al. 2011-TN4972, Kairos 2021-TN7880 | Sec 3.6.1). Uranium  
21 enrichment operation ceased in 1986, and restoration, decontamination, and decommissioning  
22 activities began soon thereafter (Kairos 2021-TN7880 | Sec 3.6.1). Reindustrialization of the  
23 site, later renamed the East Tennessee Technology Park, by DOE in cooperation with the  
24 Community Reuse Organization of East Tennessee in preparation for conversion of the site to a  
25 private sector industrial park began in 1996 (Kairos 2021-TN7880 | Sec 3.6.1). In 1998, the  
26 DOE and THC signed a Memorandum of Agreement (MOA) to resolve the adverse effects of  
27 decontamination, decommissioning as well as removal, recycling, and/or disposal of equipment  
28 associated with Buildings K-29, K-31, and K-33 as well as other ancillary activities (Kairos 2021-  
29 TN7880 | Sec 3.6.4). This MOA was amended in 2001 to discuss which diffusion equipment  
30 and displays would be retained, and upon completion of MOA stipulations, Buildings K-29, K-31,  
31 and K-33 and the ancillary facilities were demolished (Kairos 2021-TN7880 | Sec 3.6.4).  
32 Currently, the site is a brownfield.

### 33     3.5.1.2   *Historic and Cultural Resources at the Kairos Hermes Reactor Site*

34     In 2011, DOE completed an EA prior to transferring the land and facilities within the East  
35 Tennessee Technology Park to the Community Reuse Organization of East Tennessee.  
36     According to DOE's EA, no prehistoric archaeological resources are known to exist within the  
37 East Tennessee Technology Park, which also includes the proposed Hermes site. This is due  
38 to the massive cut and fill excavation activities associated with the construction, demolition, and  
39 decontamination of the former K-25 site and associated facilities (i.e., K-33 and K-31). As a  
40 result, there are likely no intact archaeological sites to be found within the East Tennessee  
41 Technology Park (DOE 2011-TN4888). A review of THC files indicates that there are no extant  
42 architectural resources within the direct-effects APE.

43     The Manhattan Project National Historical Park (NHP, established in 2015, is the only NRHP-  
44 eligible property located within the indirect-effects APE. The Manhattan Project NHP is jointly  
45 operated and administered by the DOE and the NPS (DOI 2022-TN7957). The Manhattan  
46 Project NHP consists of the K-25 History Center, which opened in 2020 and focuses on the men

1 and women who built and operated the ORDF during the Manhattan Project and Cold War. The  
2 proposed viewing platform and associated exhibits will help visitors understand the scope and  
3 magnitude of the site, while they learn about the personal stories of the workforce (DOE 2022-  
4 TN7897). Future plans include construction of a viewing platform and wayside exhibits that are  
5 the final components of the previously mentioned MOAs related to the K-25 site (TN7897).

6 To verify the NRC's decision to delineate the indirect-effects APE to 0.5 mi radius around the  
7 proposed site, the NRC staff requested that Kairos take viewshed photographs from four known  
8 historic and cultural resources located within the vicinity of the proposed Kairos Hermes site  
9 (1 mi) but outside of the 0.5 mi area. These historic and cultural resources include the following:  
10 the Wheat Community Historic District (archaeological district); the Wheat Community African  
11 Burial Ground, Gallaher, and Ellis cemeteries; and the NRHP-eligible George Jones Memorial  
12 Baptist Church. Kairos provided the photographs as supplemental information, which confirms  
13 that the proposed project area is not visible from these historic and cultural resources due to  
14 screening from topographic features and vegetation (Kairos 2022-TN7926)(see Appendix F).

15     3.5.1.3     *Traditional Cultural Properties*

16 The Kairos ER states that previous cultural resource surveys have identified eight sites within  
17 the vicinity of ORR that include mounds and/or are known human burial sites, which could be  
18 considered sacred sites (Kairos 2021-TN7880 | Sec 3.6.2). None of these sites is located  
19 within the direct- or indirect-effects APE. The results of NRC's NHPA Section 106 consultation  
20 conducted with Tribes that attach cultural or religious significance to historic properties also  
21 indicate that no traditional cultural properties are known to be located within the Hermes direct-  
22 or indirect-effects APE at the time of publishing this draft EIS (see Appendix C).

23     3.5.1.4     *Consultation*

24 The NRC initiated consultation via a letter dated March 4, 2022, with the THC (NRC 2022-  
25 TN7927), the ACHP (NRC 2022-TN7928), NPS (NRC 2022-TN7929), and 18 Federally  
26 recognized Tribes (Absentee Shawnee Tribe, Alabama-Coushatta Tribe of Texas, Alabama-  
27 Quassarte Tribal Town, Cherokee Nation, Chickasaw Nation, Eastern Band of Cherokee  
28 Indians, Coushatta Tribe of Louisiana, Delaware Nation, Eastern Shawnee Tribe of Oklahoma,  
29 Jena Band of Choctaw Indians, Kialegee Tribal Town, Muscogee (Creek) Nation, Poarch Band  
30 of Creek Indians, Seminole Nation of Oklahoma, Seminole Tribe of Florida, Shawnee Tribe,  
31 Thlophlocco Tribal Town, and United Keetoowah Band of Cherokee Indians). All letters are  
32 presented in Appendix C. There are no Federally recognized Tribes located within the State of  
33 Tennessee. The results of the NHPA Section 106 consultation efforts completed to date are  
34 described below. NRC's NHPA Section 106 consultation is ongoing and will be finalized in the  
35 Final EIS.

36 On March 11, 2022, the THC replied by letter stating that the project as currently proposed  
37 would not adversely affect the Manhattan Project NHP (THC 2022). Additionally, the THC has  
38 no objection to the implementation of this project as currently planned (THC 2022-TN7930).

39 The NRC conducted a virtual joint public outreach and scoping meeting on March 23, 2022  
40 (NRC 2022-TN7933). No comments regarding historic and cultural resources were provided at  
41 the meeting.

42 On March 30 and 31, 2022, the Chickasaw Nation stated that the proposed project is outside its  
43 area of interest and declined the NRC's request for government-to-government consultation  
44 (Chickasaw 2022-TN7931, Chickasaw 2022-TN7932).

1 By letter dated April 12, 2020, the NPS expressed an interest collaborating with Kairos and/or  
2 the NRC to develop interpretative material at or in proximity to the proposed Kairos facility site  
3 that illustrates the history of nuclear science and technology and demonstrates linkages to the  
4 work done at K-25 during World War II (DOI 2022-TN7957). The NPS noted that it is currently  
5 working with Roane County to develop interpretation and recreation programs based at and  
6 near the waterways near the K-25 site (DOI 2022-TN7957). Additionally, the NPS expressed  
7 concerns related to other DOE planned development in the area, particularly the Oak Ridge  
8 Airport and the potential impacts to on public access to the Manhattan Project NHP.

9 The NRC conducted follow-up calls with Tribes in April 2022. The Eastern Shawnee Tribe  
10 stated via letter (Eastern Shawnee 2022-TN7934) that they find no known properties of  
11 historical and/or cultural significance to the Tribe that will be affected by this project. However,  
12 if this project inadvertently discovers an archeological site or object(s), the Eastern Shawnee  
13 requested that the Tribe and appropriate State agencies be contacted immediately (within  
14 24 hours) and that all ground-disturbing activity stop until the Tribe and State agencies are  
15 consulted (TN7934).

16 The Delaware Nation responded that Tennessee is outside of their area of interest (Delaware  
17 Nation 2022-TN7935 | ML22095A221), and the Poarch Band of Creek Indians stated that the  
18 location of the project appears to be outside their area of interest (Poarch Band 2022-TN7936 |  
19 ML22095A224). On April 6, 2022, the Seminole Nation of Oklahoma accepted the NRC's  
20 invitation to participate in the environmental scoping process (Seminole Nation 2022-TN7937 |  
21 ML22109A188). On May 2, 2022, the NRC staff conducted a teleconference with the Tribal  
22 Historic Preservation Officer from the Cherokee Nation to discuss the proposed project, the  
23 associated direct- and indirect-effects APE, and potential impacts on historic and cultural  
24 resources. At the conclusion of the teleconference, the Cherokee Nation representative  
25 requested copies of cultural resource surveys completed in the vicinity of the proposed project.  
26 On May 17, 2022, NRC staff followed up its teleconference with an email-mail summarizing the  
27 contents of the discussion and indicated that the NRC had requested copies of the cultural  
28 resources reports from the Tennessee Division of TDOA and would send them to the Cherokee  
29 Nation upon their receipt (NRC 2022-TN7958). On July 6, 2022 NRC staff submitted the  
30 cultural resources reports to the Cherokee Nation THPO. (NRC 2022-TN7958).

### 31     **3.5.2     Environmental Impacts of Construction**

32 The proposed footprint of disturbance for the Hermes project is composed entirely of land that  
33 was previously used for industrial purposes (i.e., brownfield). No historic and cultural resources  
34 are known to exist within the proposed project area due to the massive cut and fill excavation  
35 activities associated with the construction of the former K-25 site and associated facilities  
36 (i.e., Buildings K-33 and K-31) and their subsequent decontamination, demolition, and  
37 decommissioning. As discussed by DOE (DOE 2011-TN4888), lease and/or deed restrictions  
38 require that if an unanticipated discovery of cultural materials (e.g., human remains, pottery,  
39 weapon projectiles, and tools) or sites is made during any development activities, all ground-  
40 disturbing activities in the vicinity of the discovery would be halted immediately. Per the deed  
41 restrictions, Kairos would develop and implement an Archaeological Monitoring and Discovery  
42 Plan that would establish stop work and notification procedures to address the unexpected  
43 discovery of human remains or archaeological material (Kairos 2021-TN7880 | Section 4.6.1,  
44 Kairos 2022-TN7902, DOE 2017-TN5081). These procedures would be in place prior to  
45 commencing ground-disturbing activities (Kairos 2022-TN7902). If human remains or  
46 archaeological resources were discovered, work would cease in the area, and notifications  
47 would be made in accordance with Tennessee law (T.C.A. § 11-6-107 et seq.-TN7938).

1 If human remains were discovered, Kairos would also notify appropriate local law enforcement.  
2 If the human remains were determined to be archaeological in nature, Kairos would notify the  
3 Tennessee Division of Archaeology and the THC to determine what further actions would be  
4 taken (Kairos 2021-TN7880 | Sec 4.6.1, Kairos 2022-TN7902).

5 No impacts are expected to occur on traditional cultural properties of significance to American  
6 Indian Tribes because none have been identified in the direct- or indirect-effects APE at the time  
7 of publishing this EIS.

8 The Manhattan Project NHP is located at the site of the former K-25 plant that was demolished  
9 and is the only NRHP-eligible site located within the indirect-effects APE. The major structures  
10 to be constructed for the proposed project would not exceed 100 ft in height. The overall visual  
11 setting of the proposed project is predominantly industrial and is in keeping with the current  
12 setting of the historical park, which consists of a brownfield site, newly built history center, and  
13 concrete pads. Therefore, the construction of the proposed Kairos project would not adversely  
14 affect the Manhattan Project NHP.

### 15 **3.5.3 Environmental Impacts of Operation**

16 No impacts on historic and cultural resources from operations and maintenance activities are  
17 expected to occur. Operations and maintenance activities may entail ground-disturbing  
18 activities within the direct-effects APE; however, Kairos would follow its Archaeological  
19 Monitoring and Discovery Plan and applicable Tennessee law regarding inadvertent discovery  
20 of human remains.

### 21 **3.5.4 Environmental Impacts of Decommissioning**

22 Impacts from decommissioning are expected to be similar to those resulting from construction  
23 activities. Because there are no known historic properties under 36 CFR 800.4(d)(1) (TN513) or  
24 historic and cultural resources located within the proposed Hermes reactor site, impacts on  
25 these resources would not be expected during decommissioning. Decommissioning activities  
26 would involve the use of heavy equipment to remove buildings, roadways, and other structures  
27 within the APE (Kairos 2021-TN7880 | Sec 4.6.1). However, Kairos would follow its  
28 Archaeological Monitoring and Discovery Plan and applicable Tennessee law regarding  
29 inadvertent discovery of human remains.

### 30 **3.5.5 Cumulative Impacts**

31 The description of the affected environment above serves as the baseline for the assessment of  
32 cumulative impacts on historic and cultural resources. No historic and cultural resources are  
33 known to exist within the proposed Hermes project area due to the massive cut and fill  
34 excavation activities associated with the construction of the former K-25 site and associated  
35 facilities (i.e., Buildings K-33 and K-31), and its subsequent decontamination, demolition, and  
36 decommissioning. The Manhattan Project NHP is the only NRHP-eligible site within the  
37 indirect-effects APE.

38 Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
39 could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
40 TN7880). Projects within the direct- and indirect-effects APE that may have a potential  
41 cumulative impact on historic and cultural resources include ongoing infrastructure  
42 improvements and future urbanization. Past activities include adverse effects associated with

1 the decontamination, demolition, and decommissioning of K-25 and the ORGDP facilities.  
2 Adverse effects on historic properties associated with these past activities were resolved by  
3 DOE via execution of MOA(s). Ongoing and future projects listed in ER Table 4.13-1 include  
4 cleanup and redevelopment activities at the East Tennessee Technology Park, construction and  
5 operation of the Atlas facility, and redevelopment activities at the Heritage Center.  
6 Development of such projects could affect historic and cultural resources if ground-disturbing  
7 activities occur, and the severity of the impacts would vary depending upon the extent of  
8 damage caused to archaeological resources and the extent of mitigation required to address  
9 adverse effects on historic properties. If new aboveground structures are constructed as part of  
10 the present and reasonably foreseeable projects, there could be significant cumulative impacts  
11 on the Manhattan Project NHP. However, in most instances, visual impacts can be minimized  
12 using creative design and by establishing vegetative screening. Although the Manhattan Project  
13 was historically significant in U.S. national history, most of the historic structures formerly at the  
14 East Tennessee Technology Park have already been demolished. Additionally, no historic  
15 properties would be affected by development on the proposed Hermes site; therefore, no  
16 additional cumulative impacts on historic and cultural resources would occur (Kairos 2021-  
17 TN7880 | Sec 4.13.7).

18 Historic and cultural resources are nonrenewable, hence certain activities can result in an  
19 irretrievable loss of the resource. Therefore, the impact of destruction on historic and cultural  
20 resources is cumulative. Overall, the cumulative impacts of the proposed Hermes project  
21 combined with other past, present, and reasonably foreseeable future actions is substantial, but  
22 the contribution of the proposed Hermes project to those cumulative impacts would be minimal.

### 23 **3.5.6 Conclusions**

24 The NRC staff concludes that the potential direct, indirect, and cumulative impacts on historic  
25 and cultural resources would be SMALL. Even though other projects in the area surrounding  
26 the proposed Hermes site have resulted in past impacts and may potentially result in future  
27 impacts on historic and cultural resources, the Hermes project would not contribute further to  
28 those impacts. For the purposes of the NRC's NHPA review, the staff concludes that there  
29 would be no adverse effect on historic properties from the proposed project.

## 30 **3.6 Socioeconomics and Environmental Justice**

### 31 **3.6.1 Affected Environment**

#### 32 **3.6.1.1 Socioeconomics**

33 In April 2019, the NRC published NUREG-2226 (NRC 2019-TN6136), *Environmental Impact*  
34 *Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site*. The CRN site is  
35 relevant for several reasons and can reasonably serve as applicable analyses for the purpose of  
36 this EIS. First, the CRN EIS considers the environmental impacts associated with a site that is  
37 within 4 mi of the proposed Hermes reactor site, so all of the physical, geological, hydrological,  
38 and atmospheric conditions identified in the CRN EIS are very similar for the Hermes site.  
39 Second, the publication of the CRN EIS in April 2019 occurred only 2 years prior to the  
40 development of this draft EIS, so the information and data in the CRN EIS is still relevant to and  
41 useful for this project. Consequently, the NRC staff determined much of the analysis conducted  
42 for the CRN site was relevant and accurate for the assessment of socioeconomic and EJ  
43 impacts from the proposed Hermes project. For socioeconomic and EJ analyses of the Hermes  
44 project, the NRC staff used the CRN EIS's data source, the U.S. Census 2016 American  
45 Community Survey (ACS) Five-Year estimates, and identified the economic region (hereafter

1 "the region") as the counties of Anderson, Knox, Loudon, and Roane, which in aggregate  
2 contained about 87 percent of the 2019 ORR workforce (TN6136). The Hermes ER used the  
3 Census 2019 ACS Five-Year estimates and established its economic region of interest as the  
4 four-counties listed above, plus Morgan County, which are all within 10 mi of the proposed site.  
5 To leverage the analyses used in the CRN EIS with the additional information provided in the  
6 Hermes ER, the NRC staff included Morgan County in its economic region of interest for the  
7 socioeconomic and EJ analyses. However, due to an unavailability of the 2019 ACS data set,  
8 the staff incorporated Morgan County demographic data from the U.S. Census Bureau, 2020  
9 Census Redistricting Data (Population, Tabulation for State Legislative Apportionment Act-  
10 TN7959) at the Census Block Group (CBG) level of disaggregation. This decision was made  
11 after the staff determined the differences for representative counties' values in 2019 and 2020  
12 ACS datasets were within 1 percent of each other. This section describes the baseline  
13 socioeconomic and EJ characteristics: the populations and the economy of the region, and the  
14 region's infrastructure and public services.

15 The following analysis focuses on resident populations with reference to the transient and  
16 migrant worker population analyses performed for the CRN EIS. The NRC staff's definitions for  
17 demographic cohorts follow the definitions of the U.S. Census Bureau. Table 3-5, below,  
18 provides key baseline demographic data for the economic region of the proposed project.

19 **Table 3-5 2020 Population of Counties in the Economic Region**

	Tennessee	Anderson County	Knox County	Loudon County	Morgan County	Roane County
Total	6,910,840	77,123	478,971	54,886	21,035	53,404
Hispanic or Latino	479,187	2,820	28,568	5,356	299	1,011
White	4,900,246	66,044	373,790	46,419	19,029	48,094
Black or African American	1,083,772	2,841	39,853	578	971	1,302
American Indian and Alaska Native	15,539	217	1,079	95	54	161
Asian	134,302	975	11,881	450	41	341
Hawaiian/Other Pacific Islander	3,594	53	300	2	8	19
Some Other Race	23,977	272	1,776	161	64	157
Two or More Races:	270,223	3,901	21,724	1,825	569	2,319
Number of CBG		54	301	47	14	51

20 Key: CBG = Census block group.

21 The CRN EIS indicated the population of the economic region increased at an average annual  
22 rate of about 1.2 percent between 2010 and 2015, with the fastest annual growth rate (1.96  
23 percent per year) occurring in Loudon. Knox had the second highest annual growth rate  
24 projection at 1.31 percent, and Anderson the third highest at 0.57 percent. The slowest annual  
25 growth rate was in Roane (0.45 percent per year) (NRC 2019-TN6136 | Sec 2.5.1.1, Table 2-  
26 22). Expanding that analysis to account for the 2020 Census, the relative rankings between  
27 counties remained the same, with Loudon again the fastest at 4.04 percent per year, then Knox  
28 at 2.54 percent, Anderson at 0.81 percent, and Roane at 0.29 percent. However, Morgan  
29 County's 2010 population Census was 21,987, almost more than a thousand individuals than  
30 that recorded in the 2020 population Census, indicating an average annual loss of about 0.43  
31 percent. Comparisons between the CRN EIS Census data for key municipalities in the  
32 economic region show changes consistent with the county-level analyses.

1 Table 2-24 of the CRN EIS (TN6136) displays 100 years of past and projected populations for  
2 the CRN ESP site economic region. Comparison between the projected 2020 economic region  
3 estimates in the CRN EIS and the 2020 Census data for those same areas indicates the CRN  
4 EIS overestimated population growth in the economic region, ranging between 2.04 percent  
5 (Knox) and 5.15 percent (Roane), for an average of 2.62 percent. The NRC staff determined  
6 the population projections provided in the CRN EIS were reasonable and incorporate them here  
7 by reference. Based on those population projections, the staff can reasonably assume the  
8 economic region will continue to grow in population at around 1 percent per year until about  
9 2080.

10 In 2020, Loudon County had the lowest poverty rate in the economic region (13.7 percent) and  
11 ranked 12th of the 95 Tennessee counties. Roane ranked 24th with a 15.4 percent poverty  
12 rate, Knox ranked 25th with 15.8 percent, Anderson ranked 28th with 16.3 percent, and Morgan  
13 had the highest poverty rate at 22.9 percent, which makes that county 82nd in state ranking.  
14 The economic region is less racially diverse than the population of Tennessee, with more than  
15 80 percent of the population self-identifying as "White Only," and about 12 percent of the  
16 population divided between "Black or African American Only" (6.64 percent) and "Hispanic or  
17 Latino" (5.55 percent). Another 4.43 percent of the economic impact area population self-  
18 identify as "Two or More Races," and the remaining 2.64 percent is divided between the  
19 remaining single race categories.

20 The staff used Tennessee Department of Labor and Workforce Development data to report  
21 employment and unemployment data for the five-county economic region (Table 3-6). In 2020,  
22 the total labor force for the economic region was approximately 397,000 people, with about  
23 19,000 unemployed, representing 5.4 percent, a full percentage point lower than the Tennessee  
24 2020 annual unemployment rate. Almost 70 percent of those unemployed in the economic  
25 region lived in Knox County, but because of the county's much larger population, the number of  
26 unemployed did not result in a Knox County unemployment rate that was greater than that for  
27 the State. Of all the counties in the economic region, only Morgan County had an  
28 unemployment rate greater than the State's, at 7.0 percent.

29 Table 3-7 presents 2020 employment for private industries in Tennessee and the five counties  
30 of the economic region. The shaded rows provide three-digit level North American Industry  
31 Classification System code values for Goods-Producing and Service-Providing sectors of the  
32 Tennessee economy. The four-digit disaggregation numbers indicate the economic region has  
33 an active workforce of 14,300 construction workers and that roughly 116,000 more construction  
34 workers live in Tennessee and could potentially support the proposed project's construction  
35 workforce. For the purposes of this analysis, the NRC staff determined the data were not  
36 unreasonable as an approximation of the region's employment structure.

37 Sections 2.5.2.2.1 through 2.5.2.2.4 of the CRN EIS provide the NRC staff's 2019 economic  
38 characterizations of the four-counties in the CRN site's economic region and are incorporated  
39 here by reference (NRC 2019-TN6136). Morgan County has a total area of 522 square miles  
40 ( $\text{mi}^2$ ) (1,352  $\text{km}^2$ ), all but a third of a  $\text{mi}^2$  being land. The largest city in Morgan County is  
41 Harriman, with 6,136 residents. Harriman has most of its land in Roane County, and it is  
42 unclear whether Morgan County's second largest city and county seat, Wartburg, has a larger  
43 population than the Morgan part of Harriman. Wartburg has 918 residents. The three largest  
44 industries in Morgan County are manufacturing, health care, and public administration. Morgan  
45 County has developed a 19.2 ac industrial park in Sunbright, 40 mi from Interstate 75, where  
46 tenants lease county-owned buildings. Their largest tenant is Tennier Industries, which  
47 manufactures military clothing.

**Table 3-6 2020 Employment Data for the Economic Area**

	Tennessee	Anderson County	Knox County	Loudon County	Morgan County	Roane County	Total Economic Region
<b>Total labor force</b>	3,454,168	36,308	255,750	24,574	8,325	24,633	397,210
<b>Employed</b>	3,234,116	34,176	242,457	23,182	7,745	22,987	330,547
<b>Unemployed</b>	220,052	2,132	13,293	1,392	580	1,646	19,043
<b>Unemployment rate</b>	6.4%	5.9%	5.25%	5.77%	7.0%	6.7%	5.45%

2

Source: State of Tennessee 2021-TN7960.

**Table 3-7 2020 Private Employment by Industry for the Economic Region**

	Industry	Tennessee	Anderson County	Knox County	Loudon County	Morgan County	Roane County	Total Economic Region
101 Goods-producing		476,156	13,059	25,649	5,033	398	1,279	45,418
1011 Natural resources and mining		11,134	24	339	583	0	0	946
1012 Construction		130,050	1,147	12,364	811	0	0	14,322
1013 Manufacturing		334,972	11,888	12,945	3,639	318	899	29,689
102 Service-providing		2,026,094	21,701	176,262	9,612	1,182	14,616	223,373
1021 Trade, transportation, utilities		627,005	4,771	50,101	4,201	306	2,712	62,091
1022 Information		42,929	235	4,361	153	31	46	4,826
1023 Financial activities		155,926	1,280	12,720	364	49	240	14,653
1024 Professional & business services		414,644	7,163	37,929	1,205	210	8,183	54,690
1025 Education and health services		421,097	4,467	39,250	1,427	398	1,823	47,365
1026 Leisure and hospitality		293,033	3,166	25,355	1,770	148	1,373	31,812
1027 Other services		70,977	617	6,536	493	39	238	7,923
1029 Unclassified		482	1	12	0	0	0	13

4

Source: BLS 2020-TN7961.

1 Comparison of 2019 and current tax data indicates the tax structures in Anderson, Knox,  
2 Loudon, and Roane Counties have not changed since publication of the CRN EIS, and their  
3 data are incorporated here by reference (NRC 2019-TN6136). Morgan County has a complex  
4 property tax formula that results in an average rate of 7 mils (0.7 percent of a structure's  
5 appraised value). Tennessee assesses a 7 percent sales tax and allows local governments to  
6 add up to 2.75 percent (in quarter percent increments) for local revenue. Morgan County adds  
7 2 percent to the Tennessee sales tax, for a total sales tax of 9 percent.

8 Vehicles access the ORR by State Route (SR) 58/Interstate-40 running east and west to the  
9 south of Clinch River and the proposed site, and SR 61 north of the ORR and running east and  
10 increasingly northward. From these main arteries, SR 95, SR 327, and SR 58 bring traffic  
11 closer to the ORR, where local roads provide the final leg of the journey. One major and one  
12 minor rail line also provide transportation routes to the ORR, and barge transportation via the  
13 Clinch River is possible.

14 In 2015, AECOM Technical Services, Inc. (AECOM) completed a traffic impact study for the  
15 CRN application. In 2021, Kairos commissioned a traffic study that determined the annual  
16 average daily traffic volumes for roads serving the ORR have grown at a rate of 2 percent per  
17 year over a 6-year period (Kairos 2021-TN7880). The NRC staff compared the data from the  
18 two studies and determined the data in the AECOM traffic study for the CRN EIS are still  
19 relevant and timely and the study is incorporated here by reference (TN6136 | Sec 2.5.2.4.1).  
20 The NRC staff also inspected the anonymized location records process used for the Kairos  
21 traffic study for estimating traffic volumes and determined that the process is reasonable. The  
22 staff therefore accepts the applicant's 2 percent annual growth assessment for the purposes of  
23 this EIS and applies it to the AECOM study conclusions.

24 The data provided in the CRN EIS is only 3 years old and is incorporated by reference here  
25 regarding the recreational characterization of the economic region for the proposed project  
26 (TN6136 | Sec 2.5.2.5). Morgan County is home to Frozen Head State Park and Natural Area,  
27 the headwaters of the Obed Wild and Scenic River, Lone Mountain State Forest, Catoosa  
28 Wildlife Management Area, Historic Rugby Tennessee, the Historic Brushy Mountain  
29 Penitentiary, and part of the Big South Fork National River and Recreation Area.

30 The CRN EIS reported about 27,400 housing units were available for purchase or rent in the  
31 EIS's economic region, along with almost 10,000 hotel rooms, most of which are in the Knoxville  
32 metropolitan area, and close to 1,500 camping sites. Given that the CRN EIS was published in  
33 2019 and data are unlikely to have changed significantly since that time, the NRC staff  
34 determined the numbers established in the CRN EIS are still relevant and can reasonably be  
35 assumed to be accurate. Therefore, the conditions associated with housing in the CRN EIS are  
36 incorporated here by reference (NRC 2019-TN6136 | Section 2.5.2.6, Table 2-35).

37 Infrastructure assessments in the CRN EIS (TN6136) cover the following key points:

- 38 • The land planned for the proposed project is an abandoned industrial area, and no  
39 additional infrastructure (utilities, roadways, or rail systems) is needed to build or operate the  
40 proposed facilities
- 41 • The CRN EIS reported a current (2019) excess water capacity of over 65 mgd in the four-  
42 counties of its economic region, with the largest excess occurring in Knox County  
43 (55.7 mgd) and the smallest in Loudon County (a deficiency of about 0.2 mgd) (see  
44 Table 2-36).

- 1     • Public wastewater treatment systems in the four-county economic region indicated a similar  
2     trend, with a total excess capacity of about 33 mgd. Knox County had the highest excess  
3     capacity, with 22 mgd, and Loudon County had the lowest excess capacity, with 0.4 mgd  
4     (see Table 2-37).
- 5     • For the CRN EIS economic region, the NRC staff reported the 2019 law enforcement level at  
6     1,300 officers and 800 civilian support staff, for a total of 2,100 law enforcement employees  
7     in the CRN four-county economic region. This results in 3.8 law enforcement officers for  
8     every 1,000 residents for Anderson County, 3.5 officers in Knox County, 2.3 officers in  
9     Loudon County, and 2.8 officers in Roane County. The national average is 2.8 officers for  
10    every 1,000 residents (see Table 2-38).
- 11    • The CRN EIS reports that the four-county economic region was served by 36 fire  
12    departments staffed by 1,167 firefighters. Anderson County has eight fire departments and  
13    214 firefighters, for a ratio of 2.8 firefighters for every 1,000 residents. Knox County has  
14    eight fire departments and 592 firefighters, or 1.3 firefighters per 1,000 residents. Loudon  
15    County has seven fire departments and 166 firefighters, for a ratio of 3.3 firefighters per  
16    1,000 residents, and Roane County has 13 fire departments and 195 firefighters, for a ratio  
17    of 3.7 firefighters per 1,000 residents. The four-county economic region has a ratio of 544:1,  
18    or 544 residents for each firefighter.
- 19    • The social services network that is discussed in the CRN EIS also serves Morgan County.
- 20    • The CRN EIS economic region contains 151 public schools, with 86,300 students and 5,900  
21    teachers. The NRC staff determined the same ranking shown for water and wastewater  
22    infrastructure also applies to schools, with Knox County having 90 schools and Loudon  
23    County having only 3 schools. The CRN EIS indicates the student-to-teacher ratios for each  
24    of the economic region counties were well within Tennessee's mandated 25:1 ratio (see  
25    Table 2-39).

26    Morgan County has three water service district providers—Plateau Utility, Sunbright Utility, and  
27    Wartburg Utility. Plateau Utility maintains a 2.4 mgd water plant and has a 150 million gal raw  
28    water reservoir in the Liberty area of Morgan County. Plateau has a total average daily water  
29    usage of 1 million gal and a 1.4 mgd excess capacity. Plateau Utility along with Cumberland  
30    Utility District provides around 240,000 gallons per day (gpd) of water for the Sunbright Utility  
31    District (NRC 2022-TN7962). The cities of Sunbright and Wartburg both have public sewer  
32    systems within their incorporated city limits. The Wartburg system has a current usage of  
33    700,000 gpd and total system capacity of 1.3 mgd.

34    There are two police departments in Morgan County—a Ranger Station at the Frozen Head  
35    State Park and Natural Area, and the Wartburg Police Department—with a total of 402 officers.  
36    Compared to other counties, Morgan County, TN, has an unusually high number of residents  
37    working as Law Enforcement Workers Including Supervisors (5.7 times higher than expected),  
38    or more than 19 officers per 1,000 residents. There are 12 fire departments in Morgan County,  
39    TN, 10 volunteer departments serving individual communities, and 1 Federal fire department for  
40    the Division of Forestry—for a total of 150 firefighters or 7.1 firefighters for every 1,000 residents  
41    (Data USA 2022-TN7963). Morgan County School District is in Wartburg and has about 2,800  
42    students in grades PK, K-12, and a student-teacher ratio of 14 to 1. This ratio is also well within  
43    Tennessee's mandated 25:1 student-teacher ratio (ECS 2014-TN5395).

44    Applying the same reasoning for accepting the 2019 CRN EIS data for housing, the staff  
45    concluded that the data for public infrastructure (transportation, water and sewerage; police, fire,  
46    and medical services; social services; schools; and hospitals) in the economic region for the

1 proposed project has not changed significantly since the publication of the CRN EIS and is  
2 incorporated here by reference (Section 2.5.2.7).

3 **3.6.1.2 Environmental Justice**

4 In 1994, the President signed Executive Order 12898, “Federal Actions to Address  
5 Environmental Justice (EJ) in Minority Populations and Low-Income Populations,” (59 Federal  
6 Register [FR] Part 7629) establishing requirements for each Federal agency to identify and  
7 address, as appropriate, the disproportionately high and adverse human health and  
8 environmental effects of its programs, policies, and activities on minority and low-income  
9 populations. While the EO did not identify specific minorities to be included in EJ assessments,  
10 further guidance in 1997 from the CEQ directed Federal agencies to assess the human health  
11 and environmental effects of agency actions on six races: Black or African American, American  
12 Indian or Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, some other race  
13 (not mentioned above), and Two or More Races (i.e., multiracial); and the ethnic populations of  
14 Hispanic or Latino (of any race) individuals.

15 CEQ established the low-income status as being individuals or families living below the poverty  
16 level as defined by the U.S. Census Bureau's Current Population Reports, Series P-60 on  
17 Income and Poverty (CEQ 1997-TN452). Because the NRC is an independent agency, CEQ’s  
18 guidance is not binding on it; however, the NRC does consider CEQ’s guidance on EJ when  
19 performing this procedure.

20 Table 3-5 above displays the racial and ethnic distribution of populations in the economic region  
21 for the five counties identified by this EIS. Knox County has the largest total population and the  
22 largest population of minorities, with slightly more than 100,000 minority residents—about 22  
23 percent of its total population. Morgan County has the smallest total population of the economic  
24 region with around 21,000 residents, with about 2,000 self-identifying as minorities—less than  
25 10 percent of the total population. Anderson (14 percent minorities), Loudon (15 percent), and  
26 Roane (8 percent) Counties complete the list.

27 The staff's first step in the review of EJ issues is to examine each CBG that is fully or partially  
28 within the economic region to determine whether that CBG should be considered a potentially  
29 affected EJ community. If application of either of the two criteria discussed below identifies a  
30 CBG, that CBG is a potentially affected EJ area.

- 31 • The EJ population for any one of the six EJ categories exceeds 50 percent of the total  
32 population of the CBG.

33 or

- 34 • The percentage of the EJ population in the CBG is at least 20 percentage points greater  
35 than that same EJ population's percentage in the block group's State.

36 The applicant established the demographic region for EJ purposes to be a 5 mi radius from the  
37 center of the proposed project and determined none of the 14 CBGs within the demographic  
38 region met either of the two percentage criteria listed above (Kairos 2021-TN7880 | Sec 3.9).  
39 The applicant concluded “there are no minority populations subject to consideration as potential  
40 environmental justice communities of concern” in the demographic region.

41 The NRC staff guidance in LIC-203 Rev 4 states, “In determining the location of minority and/or  
42 low-income populations, the geographic area within a 50 mi radius is typically large enough to  
43 encompass the entire area of potential effect so the staff can perform its comparative analysis.”

1 (NRC 2020-TN6399 | LIC-203 Rev 4). Consequently, the staff determined the applicant's 5 mi  
2 analysis was not appropriate for the assessment of EJ issues. Instead, due to the recent nature  
3 of the CRN EIS's assessment and the proximity of the proposed CRN site to the Hermes site  
4 (within 4 mi), the staff considers the CRN EIS EJ analysis to be a sufficient analysis of the EJ  
5 characteristics of the Hermes site and incorporates by reference the CRN EIS EJ analyses.

6 The EJ discussion below provides an overview of the CRN EIS's EJ analysis (NRC 2019-  
7 TN6136 | Table 2-40 and Figures 2-29 and 2-30).

8 The CRN EIS identified 760 CBGs within a 50 mi radius of the proposed site, with 3.6 percent of  
9 the population self-identifying as having an "Aggregate Minority" status and 2.1 percent as  
10 having a "Black or African American" status that exceeded the threshold established by LIC-203  
11 for a potentially affected EJ population. The largest concentrations of both Aggregate Minority  
12 and Black populations in the 50 mi radius occurred in Knox County, primarily because of the  
13 concentration of Black residents. None of the CBGs studied had EJ populations that exceeded  
14 the LIC-203 criteria for Asian, Other Races, or Two or More Races. About 7.6 percent of the  
15 CBGs studied had a low-income population that exceeded one of the threshold criteria; the  
16 greatest concentration of CBGs that exceeded one of the threshold criteria is in Knox County  
17 (NRC 2019-TN6136). The closest CBGs that exceeded an LIC-203 threshold are about 8 mi  
18 north of the CRN site. The CRN EIS review team did not identify any communities that have  
19 any subsistence or other unique practices that would provide a pathway for EJ effects from the  
20 proposed project.

## 21 **3.6.2 Environmental Impacts of Construction**

### 22 **3.6.2.1 Socioeconomics**

23 The applicant stated in its ER that "the construction phase of this project is estimated to require  
24 an estimated [sic] average of 212 onsite workers (425 at peak time)" over a two-year  
25 construction schedule (Kairos 2021-TN7880 | Sec 2.1). NRC staff practice for estimating the  
26 impact of workers migrating into the economic region considers only the impact of peak project  
27 employment, thereby establishing that parameter as an upper bound for both the impact of  
28 smaller workforce sizes and for the duration of that impact. For the CRN EIS, TVA estimated a  
29 total workforce of 3,300 at peak employment for a 6-month period near the middle of the  
30 72-month construction schedule (NRC 2019-TN6136), approximately eight times the size of the  
31 anticipated Hermes workforce and three times the length of the construction period. Of the  
32 3,300 peak employment workforce, the CRN EIS estimated about one-third of the workers  
33 (1,115 workers) would be in-migrating workers (NRC 2019-TN6136). However, the Kairos ER  
34 claimed that for the construction of the project, "[t]here are no estimated labor force deficiencies  
35 [in the economic region of interest]" (Kairos 2021-TN7880 | Sec 4.7.1.1). Based upon recent  
36 experience with assessing new reactor impacts, the staff does not agree with that assessment.  
37 To establish a reasonable upper bound for the magnitude of in-migrating specialized labor, the  
38 staff applied the assumptions of the CRN EIS as an upper bound for the impacts of the Kairos  
39 construction-related impacts analysis, given that the anticipated construction workforce for an  
40 advanced test reactor is expected to be smaller than that for a power reactor.

41 Table 3-6 shows the rate of unemployment for each of the five counties in the economic region  
42 and Table 3-7 displays the 2020 private employment for key industries in the economic region.  
43 Knox County had the lowest unemployment rate in 2020, with 5.4 percent, and Loudon had the  
44 highest, at 7 percent. On average across the economic region, the unemployment rate was  
45 5.45 percent, representing about 19,000 workers. Even if all the workers needed for the

1 project's construction phase were to come from that local unemployment pool, unemployment  
2 would decrease by only about 2 percent.

3 In 2020, the economic region held more than 14,000 construction workers, 85 percent of whom  
4 resided in Knox County. However, the construction of nuclear facilities requires the employment  
5 of highly specialized skilled labor that meets the quality assurance requirements of 10 CFR Part  
6 50 Appendix B (NEI 2000-TN6268), Criteria I and II for certification of nuclear capable skills.  
7 Even though the area surrounding Oak Ridge is unique in that it contains a large representation  
8 of nuclear-related services and workers, it is not unreasonable to anticipate some of the nuclear  
9 qualified skilled labor needed for construction of the Hermes facilities would need to migrate into  
10 the area from more than 100 mi away, necessitating long-term relocation to the economic  
11 region. As an upper bound for the potential impacts of in-migrating workers, the NRC staff  
12 assumed a third of the maximum construction workforce (about 140 workers) would need to in-  
13 migrate, given that the anticipated construction workforce for an advanced test reactor is  
14 expected to be smaller than that for a power reactor. This increase in population for the  
15 economic region would fall well within the population growth rates anticipated by local  
16 governments.

17 Similarly, the impact on socioeconomic components of the economic region derives from  
18 changes resulting from the presence of in-migrating workers as they compete for local goods  
19 and services and provide additional congestion on local roads. Assuming each of the in-  
20 migrating workers came with their families, applying the Tennessee average household size of  
21 2.53 people (USCB 2016-TN4965), the total number of in-migrating people for the two-year  
22 construction phase of the Hermes project would be about 350 people, an increase of one-  
23 twentieth of 1 percent of the current economic region population. Even if all the in-migrating  
24 workers and their families were to move to the least populated of the economic region's  
25 counties, Morgan County (21,000 people), the increase in population would still account for less  
26 than 2 percent of the county's resident population.

27 Traffic impacts are derived from the entire workforce, not only the in-migrating workers that  
28 affect other aspects of the economic region. At peak employment, the NRC staff expects 425  
29 round trip employee commutes per day, as well as any additional traffic related to shipments  
30 and deliveries (about 220 per month). The applicant's ER indicates traffic in the vicinity of the  
31 ORR increased between 2014 and 2018 at an average rate of about 2 percent per year, far  
32 lower than the magnitude needed to reduce the Level of Service (LOS, a road quality ranking  
33 from A to F) of any route into the East Tennessee Technology Park (Kairos 2021-TN7880 | Sec  
34 3.7.2.3.1). AECOM reported a peak morning traffic magnitude of more than 2,200 vehicles per  
35 hour (NRC 2019-TN6136 | Table 2-34). The distribution of an additional 425 construction  
36 workers commuting for a single-shift construction schedule would add about 20 percent to the  
37 traffic volume for the short morning and evening commute periods, potentially enough to reduce  
38 the LOS on some roads but not sufficient to reduce the LOS to a level below the "D" LOS  
39 established as acceptable by the State of Tennessee (AECOM 2015-TN5000). Deliveries and  
40 shipments during construction includes about 32,000 gal of fuel per month (about 224,000 lb, or  
41 28 small tanker trucks at the 80,000 lb load limit) and occasional deliveries of equipment and  
42 supplies (Kairos 2021-TN7880 | Sec 4.4.3.1.1). Because the additional traffic from so few  
43 Kairos activities would be added to the existing traffic in the area, shipments and deliveries each  
44 month would not be noticeable given the industrial nature of the East Tennessee Technology  
45 Park. Additionally, prior to startup, the applicant expects delivery of 20 one-ton shipments of  
46 low-pressure molten salt coolant (Kairos 2022-TN7882). Given the one-time nature of these  
47 deliveries, the impact of the shipments on traffic in the vicinity may be noticeable, but as soon  
48 as the deliveries are completed, the disruption to traffic would cease.

1    **3.6.2.2    *Environmental Justice***

2    Given the nearest potentially affected EJ populations are over 8 miles from the proposed  
3    Hermes site and given the small footprint of the proposed project, both physically and in terms  
4    of personnel, the NRC staff found no construction-related pathways by which an EJ impact  
5    could reach an EJ population. Similarly, as discussed in the CRN EIS (NRC 2019-TN6136 |  
6    Sec 4.5.6), the staff identified no unique EJ population characteristics or practices that could be  
7    affected by construction of the proposed project.

8    **3.6.3    *Environmental Impacts of Operation***

9    **3.6.3.1    *Socioeconomics***

10   The applicant stated in its ER that “During operations, an estimated average of 38 workers per  
11   weekday (68 full time positions) are required for staffing” (Kairos 2021-TN7880 | Sec 2.1). The  
12   NRC staff considers the construction workforce to establish an upper bound for the impacts  
13   from the in-migration of operations workers and their families for the duration of the anticipated  
14   four-year operations period. Some of the in-migrating construction workers may find operations-  
15   related employment with the Hermes test reactor; but because many of the in-migrating  
16   construction workers would move out of the economic region to find other work, the transition  
17   from construction to operations should result in a net decrease in demographic impacts.

18   Given that 10 CFR 50.54(m)(2) (TN249) requires continuous onsite staffing, the NRC staff  
19   assumed the 38 weekday workers would cover one shift analogous to a “business day,” and the  
20   remaining 30 workers would cover smaller evening and weekend shifts. During work  
21   commuting times, the addition of a maximum of 38 operation worker vehicles distributed across  
22   the 11 main routes into the ORR would constitute a de minimis increase in congestion and  
23   delay. Given the number of industrial-scale projects and operations on the ORR, shipments and  
24   deliveries should not be noticeable. Before the end of every 2 years of operations, the Hermes  
25   test reactor would require a resupply of 20 one-ton shipments of low-pressure molten salt  
26   coolant. As with the initial loading, the disruption to the quality of traffic during these deliveries  
27   in the vicinity would be of short duration.

28   **3.6.3.2    *Environmental Justice***

29   The NRC staff considers the EJ impacts of construction to constitute an upper bound for the EJ  
30   impacts of operation on the potentially affected EJ populations within a 50 mi radius of the  
31   proposed project. Potential unique pathways for EJ impacts may exist due to the nature of the  
32   fuel and moderator used for the test reactor but, given the distance to the closest potentially  
33   affected EJ populations (about 8 mi) and the attenuation of impacts over distance and  
34   intervening terrain, the staff did not deem the potential for EJ impacts on those populations to be  
35   more than minimal.

36   **3.6.4    *Environmental Impacts of Decommissioning***

37   **3.6.4.1    *Socioeconomics***

38   The applicant’s ER indicates the expected workforce for decommissioning would involve a peak  
39   employment level of 340 workers (Kairos 2021-TN7880 | Sec 2.1). Because the  
40   decommissioning workforce would be smaller than the construction workforce, the NRC staff  
41   assumes the impacts from construction activities would establish an upper bound for the

1 impacts from the decommissioning workforce. However, the decommissioning workforce would  
2 also be larger than the workforce needed for operation, and therefore the socioeconomic  
3 impacts from decommissioning might be slightly more noticeable than those from operations.  
4 One of the more noticeable aspects of decommissioning would relate to heavy haul traffic, with  
5 174 monthly truck shipments or deliveries (Kairos 2021-TN7880 | Sec 2.1), but the NRC staff  
6 expects a small increase over baseline traffic (about 30 percent greater than the current traffic  
7 volume, given the 2 percent per year estimate of the ER) would be absorbed into the overall  
8 volume of traffic and would not be noticeable.

9 **3.6.4.2 Environmental Justice**

10 Given that the nearest potentially affected EJ populations are more than 8 mi from the proposed  
11 Hermes site and given the small footprint of the proposed project both physically and in terms of  
12 personnel, the NRC staff found no decommissioning-related pathways by which an EJ impact  
13 could reach an EJ population. Similarly, as discussed in the CRN EIS (NRC 2019-TN6136 |  
14 Sec 4.5.6), the staff identified no unique EJ population characteristics or practices that could be  
15 affected by the decommissioning of the proposed project.

16 **3.6.5 Cumulative Impacts**

17 The Hermes project would be a part of a continuous series of nuclear projects performed at Oak  
18 Ridge, including past completed projects (Buildings K-33 and K-31 at the proposed Hermes  
19 site), projects currently under way (the Spallation Neutron Source facility, about 5 mi to the east,  
20 and the S-50 Thermal Diffusion Plant, less than 2 mi to the south-southwest), and planned  
21 future projects, such as the proposed CRN approximately 4 mi to the east and the Atlas facility  
22 (see Sections 3.0 and 3.1 for more detail). The present and future projects would compete with  
23 the proposed Hermes project for nuclear skilled labor and resources; and the proposed new  
24 general aviation airport to be constructed within the East Tennessee Technology Park creates a  
25 special safety and security concern for a nuclear reactor with respect to severe accidents.  
26 However, the interface within and between these other projects does not rise to a level that  
27 would result in an impact on socioeconomics and EJ to be above minimal. Projects farther  
28 away from the ORR that are extant or proposed have a diminishing level of impact as the  
29 distance increases between them. Consequently, the NRC staff determined the cumulative  
30 impacts on the socioeconomic and EJ aspects of the proposed project would be minimal.

31 **3.6.6 Conclusions**

32 The NRC staff concludes the potential direct, indirect, and cumulative socioeconomic and EJ  
33 impacts of the proposed action would be SMALL. This conclusion is based on three  
34 considerations: First, staff relied heavily on the Clinch River ESP EIS for each socioeconomic  
35 resource area because of that project's proximity in both time and space to the proposed  
36 project. Because the Hermes reactor is smaller than the footprint of the reactors that form the  
37 Clinch River ESP's plant parameter envelope, staff concluded the Clinch River ESP  
38 socioeconomic and EJ impacts form an upper bound to the impacts of the Hermes project.  
39 Second, the surrounding land is already in a state of industrial use and further disturbance of  
40 the proposed site would not be noticeable. Third, the applicant would not need any additional  
41 infrastructure (utilities, roadways, or rail systems) to build or operate the proposed facilities.

1    **3.7 Human Health**

2    **3.7.1 Nonradiological Human Health**

3    The following section addresses the potential effects of occupational hazards on the health of  
4    people working on or near the Hermes site, including those caused by physical, electrical, and  
5    chemical sources. Nonradiological waste is included in the chemical hazards addressed here  
6    and is discussed further in Section 3.9 of this draft EIS.

7    **3.7.1.1 Affected Environment**

8    According to the applicant, no radioactive or hazardous materials are currently stored on the site  
9    (Kairos 2021-TN7880 | Sec 3.8.3). The applicant describes how DOE has remediated past  
10   contamination on the site, which previously accommodated Buildings K-31 and K-33 of the  
11   gaseous diffusion plants, to risk-based levels acceptable for transfer of the property for  
12   unrestricted industrial use (Kairos 2021-TN7880 | Sec 3.8.4). However, the applicant  
13   acknowledges that residual radioactive and nonradioactive contaminants might still be present  
14   in soils and groundwater at the site above background levels but below risk-based standards for  
15   industrial uses (Kairos 2021-TN7880 | Sec 3.8.3). The applicant provides relevant statistics for  
16   occupational injury and fatality rates for construction, operation, and decommissioning of similar  
17   facilities in the United States in Section 3.8.7 of the ER (Kairos 2021-TN7880).

18    **3.7.1.2 Environmental Consequences of Construction**

19    Other than the residual contamination left over from previous DOE uses of the site, the potential  
20   nonradiological occupational hazards would be those typical of construction sites when building  
21   new industrial facilities. The applicant explains in Section 4.8.1 of the ER how it expects its  
22   nonradiological effects on human health to be minimal (Kairos 2021-TN7880). The applicant  
23   expects that nonradioactive chemicals possibly present on its construction site could include  
24   (petroleum-based) fuels, oils, solvents, and other materials necessary for site preparation and  
25   building new facilities (Kairos 2021-TN7880 | Sec 4.8.1.1). The applicant estimates that air  
26   emissions would be below 100 TPY for criteria pollutants under the Federal CAA (SO<sub>2</sub>, NO<sub>x</sub>,  
27   PM<sub>10</sub>, CO, VOCs, and Pb) during construction and decommissioning, and it plans to send any  
28   liquid effluent releases to the City of Oak Ridge for municipal treatment (Kairos 2021-TN7880 |  
29   Sec 4.8.1.4.1). Air emissions are discussed further in Section 3.2.1 of this draft EIS, and  
30   wastewater treatment is discussed further in Section 3.3 of this draft EIS.

31    Table 4.8-2 of the ER lists the potential types of physical, electrical, and chemical occupational  
32   hazards during the construction phase of the project (Kairos 2021-TN7880). The applicant  
33   plans to reduce or eliminate occupational physical hazards through implementation of safety  
34   practices, training, and physical control measures (Kairos 2021-TN7880 | Sec 4.8.1.5).  
35   Construction debris and other solid waste would be subject to waste reduction, recycling, and  
36   waste minimization practices (Kairos 2021-TN7880 | Sec 4.8.1.2.3). The applicant would not  
37   store or use highly hazardous chemicals on the site in quantities above the Threshold Quantities  
38   established by the U.S. Occupational Safety and Health Administration (OSHA) in Appendix A  
39   to 29 CFR 1910.119 (TN654), "List of Highly Hazardous Chemicals, Toxics and Reactives  
40   (Mandatory)" during construction (Kairos 2021-TN7880 | Sec 4.8.1.6).

41    The NRC staff finds that the applicant's conclusion that the measures noted above would  
42   minimize the potential for serious occupational injury on or adjacent to the construction site for  
43   properly trained and qualified construction workers is reasonable. The physical hazards

1 reported by the applicant to occur on the Hermes site during the construction phase of the  
2 project, as outlined in Table 4.8-2 of the ER (Kairos 2021-TN7880), are typical of industrial  
3 construction sites. Qualified construction workers could be readily trained to take the  
4 precautionary measures necessary to minimize the potential for serious injury from such  
5 hazards. For example, construction workers are routinely trained to wear hard hats, steel-toed  
6 boots, and safety goggles when around operating construction machinery.

7 Hearing injury caused by noise can be an occupational hazard at industrial sites. OSHA  
8 requires making hearing protection devices such as earmuffs and earplugs available to workers  
9 exposed to an eight-hour time-weighted average noise level of 85 dB or greater (29 CFR Part  
10 1910-TN654). The applicant indicates that several pieces of construction equipment could  
11 generate maximum noise levels of 85 or more dBA at a distance of 50 ft (Kairos 2022-TN7912 |  
12 Table 4.2-3. Even higher noise levels could be experienced by construction equipment  
13 operators who may have to sit or stand closer than 50 ft from the equipment to operate it.  
14 Although the applicant does not directly address hearing protection in its ER, compliance with  
15 health safety protections established in 29 CFR Part 1910 (TN654), "Process Safety  
16 Management of Highly Hazardous Chemicals," is mandatory. The NRC staff therefore expects  
17 that workers on the construction site would be provided access to suitable hearing protection  
18 devices and trained in their use.

19 **3.7.1.3 Environmental Consequences of Operation**

20 Most of the analysis presented above regarding nonradiological hazards to human health for  
21 construction would be true for operations as well. Because the Hermes facilities would not have  
22 cooling towers or discharges to surface waters (other than stormwater), there would be no  
23 potential for health hazards caused by exposure to biocides or discharge streams, or from  
24 microbiological hazards resulting from warmed surface waters. Because the Hermes project  
25 would not involve building or operating high-voltage transmission lines or switchyards, there  
26 should be little potential for health hazards caused by electromagnetic fields. Stormwater  
27 discharges would be monitored as required by a National Pollutant Discharge Elimination  
28 System permit (Kairos 2021-TN7880 | Sec 4.4.3.1.2). There would be no potential for  
29 operation of Hermes to cause thermal discharges to surface waters capable of inducing the  
30 growth of pathogenic microorganisms, an issue described further in Section 3.9.3 of NUREG-  
31 1437 (NRC 2013-TN2654 | Sec 3.9.3).

32 As with construction, air emissions from the proposed facilities during operation would be below  
33 100 TPY for criteria pollutants under the Federal CAA ( $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{PM}_{10}$ , CO, VOCs, and Pb)  
34 (Kairos 2021-TN7880 | Sec 4.8.1.4.1). See Section 3.2.1 of this draft EIS for more information.  
35 Nonradioactive liquid wastes from operations would be discharged to the municipal sewer  
36 system for treatment at the Rarity Ridge WWTP facility (Kairos 2021-TN7880 | Sec 4.8.1.2.1).  
37 See Section 3.3 of this draft EIS for more information. Nonradioactive gaseous wastes from  
38 operating areas would be passed through a high-efficiency particulate air filtration system before  
39 being vented to the atmosphere, and additional controls may be implemented as required by  
40 local permit conditions (Kairos 2021-TN7880 | Sec 4.8.1.2.2). Nonradioactive solid wastes are  
41 characterized in Section 4.8.1.2.3 of the ER and would be subject to waste reduction, recycling,  
42 and waste minimization practices (Kairos 2021-TN7880). Table 4.8-2 of the ER lists the  
43 potential types of physical, electrical, and chemical occupational hazards during the operational  
44 phase of the project (Kairos 2021-TN7880).

45 The applicant has stated that operations would adhere to the regulations and standards  
46 established by OSHA and National Institute of Occupational Safety and Health (NIOSH)

1 regulations (Kairos 2021-TN7880 | Sec 4.8.1.5). OSHA regulations in 29 CFR Part 1910  
2 (TN654) require implementation of specific training and notification processes to ensure the  
3 safety of workers and other persons on sites where hazardous materials and wastes are  
4 present. The NRC staff notes that compliance with the OSHA (and NIOSH) regulations is  
5 mandatory and expects that compliance would ensure the safety of properly qualified and  
6 trained site workers.

7 Flibe, a lithium, beryllium, and fluorine compound to be used as a low-pressure, molten salt  
8 coolant during operation of the Hermes reactor would be present on the site above the  
9 regulatory threshold quantity during operations and the applicant would therefore have to  
10 comply with 29 CFR 1910.119 (Kairos 2021-TN7880 | Sec 4.8.1.6). Although chemically  
11 stable, Flibe contains potentially toxic constituents, including beryllium (Kairos 2021-TN7879 |  
12 Sec 1.2.1). Workers could also be killed or injured if exposed to other chemicals used in the  
13 operation of industrial facilities such as Hermes. Flibe and most other process chemicals would  
14 be in liquid form and contained in tanks and pipes that would limit workforce exposure (Kairos  
15 2021-TN7880 | Sec 4.8.1.6). Although not credited for mitigation of radiological releases during  
16 postulated events, the reactor building and ventilation system would function as confinement to  
17 manage and control beryllium hazards (Kairos 2021-TN7879 | Sec 1.2.1), as well as other  
18 nonradiological substances. The biological shield designed to protect workers and the public  
19 from radiological exposure, described in Section 4.4.1 of the PSAR (Kairos 2021-TN7879 | Sec  
20 4.4.1), would also reduce the potential for exposure of reactor personnel to beryllium and other  
21 hazardous chemicals. The applicant designed the heating, ventilation, and air conditioning  
22 system of the reactor building to ensure that chemical hazards remain within regulatory limits  
23 (Kairos 2021-TN7879 | Sec 9.2.2). The NRC staff finds that compliance with the OSHA (and  
24 NIOSH) regulations and the design features noted above would help protect properly trained  
25 and qualified site workers from the hazards of working with and around Flibe. The potential  
26 hazards of worker exposure to Flibe and other chemicals used in operation of the Hermes  
27 facilities would be reconsidered at the OL stage once the applicant can provide more specific  
28 operational descriptions.

29 The applicant proposes in Section 4.8.1.7 of the ER to perform environmental monitoring as  
30 required by Tennessee State regulations, which may include requirements to monitor  
31 emergency management, environmental health, drinking water, water and sewage, pollution  
32 discharges, air emissions, and hazardous waste management (Kairos 2021-TN7880). The  
33 NRC staff notes that further consideration of possible nonradiological operational hazards  
34 specific to operation of the Hermes facilities may be necessary when the NRC staff conducts its  
35 environmental review of an OL application.

36 **3.7.1.4 Environmental Consequences of Decommissioning**

37 The analysis presented above related to construction and operations regarding nonradiological  
38 hazards to human health would apply to decommissioning as well. The NRC staff expects that  
39 impacts from decommissioning the Hermes facilities on nonradiological occupational safety  
40 would be bounded by the analyses reported for physical, chemical, ergonomic, and biological  
41 hazards in Section 4.3.10 of the decommissioning generic EIS (NRC 2002-TN7254), which  
42 concluded that the impacts would not be detectable. Further consideration of nonradiological  
43 health hazards may be necessary once the applicant applies for NRC approval for  
44 decommissioning.

1    3.7.1.5    *Cumulative Impacts*

2    Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
3    could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
4    Kairos 2021-TN7880). The NRC staff expects that each industrial facility in the surrounding  
5    area would comply with applicable OSHA and NIOSH regulations to ensure good occupational  
6    protection. Based on the staff's analysis of potential nonradiological human health impacts from  
7    the anticipated life cycle of the proposed Kairos Hermes facilities, the staff expects that the  
8    facilities would not substantially contribute to occupational hazards in the area. The applicant  
9    acknowledges that the nonradiological health impacts from emissions and discharges from past  
10   ORR operations in the area are noticeable, but that the incremental contribution from the  
11   proposed facilities would not be noticeable (Kairos 2021-TN7880 | Sec 4.13.8.1). The NRC  
12   staff finds that the incremental contribution of nonradiological health impacts from the Hermes  
13   project would not be noticeable, as long as the applicant complies with applicable OSHA and  
14   NIOSH regulations and implements the mitigation measures described in Section 4.8.1.8 of the  
15   ER (Kairos 2021-TN7880 | Sec 4.8.1.8).

16    3.7.1.6    *Conclusions*

17    The NRC staff concludes that the potential direct, indirect, and cumulative impacts of the  
18   proposed action on nonradiological human health would be SMALL. This conclusion is based  
19   primarily on the applicant's plans to reduce the potential for occupational physical hazards  
20   through implementation of safety practices, training, and physical control measures (Kairos  
21   2021-TN7880 | Sec 4.8.1.5) and on the applicant's plans to reduce the potential for chemical  
22   exposure hazards through design of the Hermes facilities and practices to comply with  
23   applicable regulations and limit potential exposure of workers. The NRC staff may have to  
24   reevaluate the potential for occupational hazards if the applicant submits more detailed design  
25   information for operations or decommissioning in subsequent applications. The applicant would  
26   not use cooling towers (Kairos 2021-TN7880 | Sec 4.1.2) and thus would not discharge cooling  
27   tower blowdown to surface water where it could create chemical or thermal health hazards.  
28   Effluent would instead be released only to municipal sewers, where it would have to meet  
29   requirements established by the City of Oak Ridge or be trucked away to a suitable disposal  
30   location. The NRC staff recognizes that the applicant proposes to perform environmental  
31   monitoring to protect human health as required by permitting requirements (Kairos 2021-  
32   TN7880 | Sec 4.8.1.7). The NRC staff expects that specific monitoring requirements would be  
33   called for by permits the applicant receives under the Resource Conservation and Recovery Act  
34   (TN1281), CAA (TN1141), and from the State. The NRC staff's conclusion also recognizes that  
35   the applicant has committed to implementation of administrative procedures and protective  
36   measures to ensure protection of human health and the environment, BMPs to minimize  
37   pollutant discharges and emissions, and waste reduction practices such as recycling and waste  
38   minimization (Kairos 2021-TN7880 | Sec 4.8.1.8). The NRC staff expects that no additional  
39   mitigation measures will be necessary to prevent noticeable adverse nonradiological health  
40   impacts.

41    3.7.2    **Radiological Human Health**

42    3.7.2.1    *Affected Environment*

43    As discussed in the land use section of this draft EIS (Section 3.1), the proposed Hermes test  
44   reactor would be built within the footprint of the former K-31 and K-33 gaseous diffusion plants.  
45   These two gaseous diffusion plants had various levels of chemical and radiological

1 contamination that DOE remediated as part of the demolition and decontamination of the areas  
2 prior to releasing them for industrial uses like the Hermes test reactor. DOE performed  
3 radiological surveys and environmental sampling under the DOE Environmental Management  
4 Program's Dynamic Verification Strategy process to assess the condition of the K-31 and K-33  
5 property as documented in two documents, namely the covenant deferral requests for the title  
6 transfer of the former K-31 Area and K-33 Area at the East Tennessee Technology Park (DOE  
7 2015-TN7964, DOE 2015-TN7965). As documented in these two title transfer reports, there  
8 were no exceedances of the measured maximum or average remediation level. If  
9 contamination above the remediation levels were discovered later, DOE would be required to  
10 take appropriate remediation actions. Based on the remedial actions and the environmental  
11 sampling, as documented in DOE 2015-TN7964 and DOE 2015-TN7965, the K-31 and K-33  
12 Areas have a negligible or very low radiological risk to Hermes workers consistent with EPA's  
13 guidance for the protection of human health and the environment.

14 Ongoing activities on the ORR release small quantities of radionuclides to the environment.  
15 The ORR Annual Site Environmental Report (DOE 2021-TN7915) provides estimated annual  
16 doses to a hypothetical maximally exposed individual (MEI) from radionuclides released from all  
17 DOE facilities on the ORR considering all potential pathways. The most recent report estimates  
18 the maximum annual radiation dose to the MEI in 2020 to be about 0.4 millirem (mrem) from air  
19 pathways, approximately 2 mrem from water pathways (i.e., drinking, consuming fish, swimming  
20 and other recreational uses), and 0.07 mrem from wildlife consumption (e.g., two geese)  
21 harvested on ORR (DOE 2021-TN7915). The combined 2020 dose was estimated to be  
22 approximately 3 mrem (DOE 2021-TN7915). During the 5-year period from 2016 to 2020 the  
23 estimated annual all-pathways dose to the MEI averaged about 2.6 mrem except for 2019 with a  
24 dose of approximately 6.6 mrem with 4 mrem due to the sampling of fish (DOE 2021-TN7915).

25 In addition, several non-DOE radiological facilities on or near the ORR could potentially  
26 contribute to cumulative impacts on members of the public. Based on its review of responses  
27 for the years of 2016 and 2017 from 25 nearby non-DOE facilities regarding potential radiation  
28 doses to members of the public, DOE concluded the combined annual doses from both DOE  
29 and non-DOE sources would be significantly less than DOE's annual dose limit of 100 mrem,  
30 which is the same annual dose limit in 10 CFR 20.1301 (TN283), "Dose limits for individual  
31 members of the public" (DOE 2017-TN5081, DOE 2018-TN7989). Annual doses to members of  
32 the public from direct radiation from the non-DOE facilities ranged from 0 to 25 mrem in 2016  
33 and from none to 2 mrem in 2017 (DOE 2017-TN5081, DOE 2018-TN7989).

34 Two main sources of natural background radiation exist: cosmic radiation produced by  
35 collisions of high-energy particles in the upper atmosphere, and naturally occurring terrestrial  
36 radionuclides in rocks and soils. The cosmic ray background varies with geomagnetic latitude  
37 and elevation; the cosmic ray dose rate in the region surrounding the East Tennessee  
38 Technology Park (elevation 600–1,200 ft) averages between 27 and 31 mrem per year  
39 (mrem/yr) (National Research Council 1980-TN5291). The dose rate from uranium, thorium,  
40 potassium, and related natural radionuclides depends on the underlying geology; the terrestrial  
41 dose rates in the region surrounding the East Tennessee Technology Park average between 35  
42 and 75 mrem/yr (National Research Council 1980-TN5291). When combined with the cosmic  
43 ray contribution, direct natural radiation in this area of Tennessee ranges from 62 to 106  
44 mrem/yr. Therefore, the naturally occurring background radiation dose rates at the East  
45 Tennessee Technology Park should be in the anticipated range of 62 to 106 mrem/yr, which is  
46 consistent with the United States average of about 100 mrem/yr from direct radiation (NCRP  
47 2009-TN420). The breathing of radon gas typically adds an additional natural background dose

1 of approximately 200 mrem/yr for an average total natural background of approximately  
2 300 mrem (0.3 millisievert [mSv]) per year.

3 **3.7.2.2 Environmental Impacts of Construction**

4 At certain times during construction, Kairos or a designated construction contractor would be  
5 licensed to receive, possess, and use specific radioactive byproduct, source, and special  
6 nuclear material in support of construction and preparations for operation, such as for  
7 compaction testing and radiography (Kairos 2021-TN7880). These sources of low-level  
8 radiation are required to be controlled by the radiation protection program of the holder of the  
9 radioactive material license and have very specific uses under controlled conditions. The  
10 controlled conditions would include restricting access to an area when a device using a  
11 byproduct sealed source is in use to prevent radiological exposure of the general construction  
12 workforce along with possession controls to the radioactive material. The required radiation  
13 protection procedures and monitoring of the radioactive material would ensure that doses to  
14 construction workers from such uses of sources of radiation would be well below the annual  
15 dose limits for members of the public set forth in 10 CFR 20.1301 (TN283), if not negligible.

16 As discussed in Section 3.1 of this draft EIS, the site proposed for the Hermes test reactor is the  
17 former site of Buildings K-31 and K-33, which were part of the ORGDP complex for enriching  
18 large quantities of uranium from the 1950s until operations ceased in 1985 and the site was  
19 permanently shut down in 1987. These gaseous diffusion buildings were decontaminated,  
20 demolished, and the land was remediated of any residual radiological or chemical waste to  
21 allow for unrestricted use. However, DOE would retain responsibility for any corrective actions  
22 regarding unanticipated discovery of legacy wastes, if found during the construction of the  
23 Hermes test reactor (DOE 2015-TN7964, DOE 2015-TN7965).

24 Therefore, based on the controls required for the use of radioactive devices or radioactive  
25 material during construction and DOE's remediation of the land prior to any Kairos construction  
26 activity, the NRC staff concludes the radiological impacts during construction would not be  
27 significant.

28 **3.7.2.3 Environmental Impacts of Operation**

29 This section discusses the estimated annual doses to facility workers and members of the public  
30 from the operation of the Hermes test reactor along with radiological environmental monitoring  
31 over its anticipated four-year licensing period. Based on the design of the Hermes test reactor,  
32 the expected exposure pathways to members of the public would principally be from radiological  
33 gaseous effluent release because a small volume of radioactive liquid effluent releases (i.e.,  
34 water-based releases) would be discharged to the sewer lines in accordance with 10 CFR 20  
35 Subpart K, specifically under 10 CFR 20.2003 (TN283), "Disposal by Release Into Sanitary  
36 Sewerage" and the limits of Table 3 of Appendix B to 10 CFR Part 20 (Kairos 2021-TN7880 |  
37 Sec 2.6.1.1). Additionally, Kairos will apply for a sanitary sewer and water supply permit (Kairos  
38 2021-TN7880 | Table 1.4-1) which requires that any liquid radiological discharges into the City  
39 of Oak Ridge wastewater treatment system must meet Municipal Code 18-308 (City of Oak  
40 Ridge 2022-TN7941). Based on prior dose modeling applying the maximum releases under  
41 NRC regulation, the sanitary sewerage pathway would present a sufficiently low health and  
42 safety risk to the public under the current regulatory structure (70 FR 68350-TN7940). Because  
43 Kairos would release small amounts of liquid radiological wastes that would be within regulatory  
44 limits, the exposure from this pathway is expected to be negligible. Section 4.8 of the ER

1 presents an analysis of the potential annual radiation doses to the MEI located nearby from  
2 such radiological gaseous effluent releases.

3 The annual dose limits for members of the public are provided in 10 CFR 20.1301 (TN283),  
4 specifically 10 CFR 20.1301(a) (TN283), which limits dose to 0.1 rem/yr. However, the Atomic  
5 Safety and Licensing Board Panel determined that the limits in 40 CFR 190.10 (TN739)—and  
6 hence 10 CFR 20.1301(e) (TN283)—and 10 CFR Part 50 Appendix I (TN249) do not apply to  
7 non-light water reactors (LWRs) (ASLB 2007-TN6826). Additionally, these regulations are also  
8 specifically applicable to operations associated with the production of electrical power for public  
9 use or for light-water-cooled nuclear power reactors. Therefore, because the Hermes test  
10 reactor is based on molten salt cooling (therefore a non-LWR) and would not produce electricity,  
11 this test reactor would not be subject to the requirement in 10 CFR 20.1301(e) (TN283) to  
12 adhere to the applicable environmental radiation standards in 40 CFR 190.10 (TN739) and  
13 10 CFR Part 50 Appendix I (TN249). However, other portions of 10 CFR Part 20 (TN283) apply  
14 to any users of radioactive material and are applicable to the Hermes test reactor. Regulations  
15 such as the dose limits in 10 CFR 20.1301(a) and the as low as is reasonably achievable  
16 requirements and regulations for radiation protection programs under 10 CFR 20.1101 (TN283)  
17 are applicable to non-LWR and non-power reactor licensees, and would ensure that radioactive  
18 effluent releases from non-LWRs and non-power reactors remain below applicable regulatory  
19 limits.

20 *3.7.2.3.1 Occupational Doses*

21 If an OL is issued to Kairos, they would need to control occupational doses to workers to the  
22 5 rem annual limit as specified in 10 CFR 20.1201 and incorporate the low as is reasonably  
23 achievable provisions of 10 CFR 20.1101 (TN283) to ensure occupational doses would always  
24 be below this limit.

25 *3.7.2.3.2 Doses from Radiological Gaseous Effluent Releases*

26 Following the guidance in NUREG-1537 Part 1, Kairos presents an analysis of the radiological  
27 human health impacts in Section 4.8.2 of the ER (Kairos 2021-TN7880). This section of the ER  
28 discusses the various sources of radiation (gaseous, liquid, and solid) and baseline radiation  
29 levels within the facility before providing a detailed analysis of offsite doses based on  
30 radiological gaseous effluent releases with no anticipated need for holding time to allow for  
31 decay. Only a limited amount of radiological liquid effluents would be generated and, as  
32 discussed in Section 3.9 of this draft EIS for liquid radiological waste management, these  
33 effluents would be disposed via the WWTP sewerage per 10 CFR 20.2003 (TN283) with no  
34 exposure pathway to nearby residents. The Kairos radiological gaseous effluent release  
35 analysis in Section 4.8.2.4 of the ER is based on the guidance in RG 1.111 for atmospheric  
36 long-term dispersion coefficients (NRC 1977-TN5887) and RG 1.109 methodology (NRC 1977-  
37 TN90) for calculating annual doses to members of the public from the radiological effluent  
38 releases. Both analytical processes were performed by Kairos (Kairos 2021-TN7880 | Sec  
39 4.8.2.4) with the application of the NRCDose modeling package programs XOQDOQ  
40 (Sagendorf et al. 1982-TN280) and GASPAR II (Sagendorf et al. 1982-TN280) and GASPAR II  
41 (Strenge et al. 1987-TN83, Sagendorf et al. 1982-TN280) and GASPAR II (Strenge et al. 1987-  
42 TN83), respectively, through a graphical user interface (NRC 2021-TN7050).

43 The Kairos analysis of long-term dispersion coefficients shown in ER Tables 4.8-14 through 4.8-  
44 20 is based on 5 years of meteorological data from a nearby ORR meteorological tower, Tower  
45 L, 1 mi south-southeast of the Hermes facility site, for the years 2016 to the end of 2020 (Kairos

1 2021-TN7880). During the environmental audit of the Hermes ER, the NRC staff examined the  
2 input and output files of the XOQDOQ calculations (NRC 2022-TN7954). The results of these  
3 calculations for long-term dispersion coefficients were compared to the results found for the  
4 Clinch River ESP ER, as documented in TVA's ER and the staff's final EIS (TVA 2017-TN4921 |  
5 Sec 2.7.6, NRC 2019-TN6136). Based on this review, the staff found the resulting long-term  
6 dispersion coefficients being applied by Kairos to be reasonable for use in a radiological  
7 gaseous effluent determination concerning annual doses to individual members of the public.

8 Kairos calculated the gaseous pathway doses to the MEI at a location with the greatest modeled  
9 concentration and deposition from airborne emissions (i.e., 0.5 mi south-southeast). For the  
10 actual nearest resident located at approximately 1.1 mi north-northwest of the site, the greatest  
11 modeled concentration and deposition in the eastern direction was applied for this location  
12 (Kairos 2022-TN7882). Kairos applied the GASPAR II computer program to calculate the  
13 radiological doses to these individual members of the public. The following activities were  
14 considered in the dose calculations: (1) direct radiation from submersion in the gaseous effluent  
15 cloud and exposure to particulates deposited on the ground; (2) inhalation of gases and  
16 particulates; (3) ingestion of meat from animals eating grass affected by gases and particulates  
17 deposited on the ground; and (4) ingestion of foods (e.g., vegetables) affected by gases and  
18 particulates deposited on the ground. Because there would not be any residential or agricultural  
19 properties within the boundary of the East Tennessee Technology Park, doses at the site  
20 boundary and the MEI do not include contributions from the ingestion of milk, meat, or  
21 vegetables. Meat and vegetable ingestion were included in the nearest resident's exposure  
22 pathways. Kairos did not identify any milk production in the vicinity of the Hermes site (Kairos  
23 2022-TN7882). No milk production in the surrounding area was noted in the Clinch River ESP  
24 EIS either (NRC 2019-TN6136).

25 As a bounding calculation, Kairos applied the annual gaseous radiological release values from  
26 Table 3.5-4 of Revision 2 of the Clinch ESP ER (TVA 2017-TN4921) along with a bounding  
27 tritium emissions rate of approximately 62,500 curies per year (Ci/yr) (Kairos 2022-TN7902).  
28 Other parameters used as inputs to the GASPAR II program include vegetable production rates,  
29 meat production rates, long-term atmospheric dispersion factors, receptor locations, and  
30 consumption factors that the staff independently verified as being adequate for this analysis.  
31 Gaseous pathway doses at the site boundary to the MEI and the nearest resident, as calculated  
32 by Kairos, are shown in Table 3-8 of this draft EIS.

33 Kairos states in the ER that the total body and organ dose estimates for the MEI from gaseous  
34 effluents at the Hermes site would not be in excess of the 10 CFR 20.1101(d) constraint, which  
35 is a total effective dose equivalent (TEDE) of 10 mrem (0.1 mSv) per year and the 10 CFR  
36 20.1301(a)(1) TEDE limit of 100 mrem (1 mSv) (TN283). The TEDE annual doses at several  
37 locations from the combined external dose and radiological gaseous effluents are presented in  
38 Table 3-9. Based on the fact that the Hermes reactor itself is in a heavily shielded area within  
39 the Hermes Reactor Building, direct radiation dose rates in the vicinity of facility are expected to  
40 be generally undetectable and less than 1 mrem/yr. This is based on the monitoring experience  
41 at LWR site boundaries (NRC 2013-TN2654). For this EIS, the NRC staff completed an  
42 independent evaluation of Kairos's NRCDose calculations by reviewing the inputs and  
43 subsequent results, allowing for further comparisons to the radiological dose analysis conducted  
44 under the Clinch River ESP ER, and found that the Kairos Hermes analysis was adequate. As  
45 indicated in Table 3-9, the resulting annual doses are in compliance with 10 CFR Part 20  
46 Subparts B and D (TN283) for annual doses and a very small fraction of the annual natural  
47 background radiation exposure level of 300 mrem.

1      **Table 3-8 Radiological Doses from Annual Radiological Gaseous Effluent Releases**

<b>Location</b>	<b>Pathway</b>	<b>Annual Dose Rate (mrem/yr)</b>				<b>Maximum Organ</b>
		<b>Total Body</b>	<b>Thyroid</b>	<b>Maximum Organ</b>		
Site boundary (0.2 mi, north east)	External	Plume	5.7E-02	5.7E-02	1.8E-01	Skin
		Ground	8.0E-02	8.0E-02	1.4E-01	
		Subtotal	1.4E-01	1.4E-01	3.2E-01	
	Inhalation	Subtotal	4.3E-01	5.1E-01	5.2E-01	Thyroid
	Ingestion	Subtotal			N/A <sup>(a)</sup>	
	<b>TOTAL</b>		5.7E-01	6.5E-01	5.2E-01	Thyroid
MEI (0.5 mi, SSE)	External	Plume	1.5E-01	1.5E-01	4.9E-01	Skin
		Ground	4.0E-02	4.0E-02	6.8E-02	
		Subtotal	1.9E-01	1.9E-01	5.6E-01	
	Inhalation	Subtotal	1.2E+00	1.5E+00	1.5E+00	Thyroid
	Ingestion	Subtotal			N/A <sup>(b)</sup>	
	<b>TOTAL</b>		1.4E+00	1.7E+00	1.5E+00	Thyroid
Analytical nearest resident (1.1 mi, east) <sup>(c)</sup>	External	Plume	5.2E-02	5.2E-02	1.7E-01	Skin
		Ground	2.2E-02	2.2E-02	3.8E-02	
		Subtotal	7.4E-02	7.4E-02	2.1E-01	
	Inhalation	Subtotal	4.6E-01	5.5E-01	5.5E-01	Thyroid
	Ingestion	Subtotal	6.5E-01 <sup>(d)</sup>	8.2E-01 <sup>(d)</sup>	8.2E-01 <sup>(d)</sup>	Thyroid
	<b>TOTAL</b>		1.2E+00	1.4E+00	1.6E+00	Thyroid

Key: mrem/yr = mrem per year; mi = miles ; N/A = not applicable;  $\chi$  = atmospheric dispersion factor(s); Q = annual average normalized air concentration value(s).

- (a) The ingestion pathway at the site boundary is not applicable; there is no production of food products at the site boundary.
- (b) The MEI location is within the boundary of the East Tennessee Technology Park; the ingestion pathway at the MEI location is not applicable; there is no production of food products inside the boundary of the East Tennessee Technology Park.
- (c) The nearest residence is north-northwest at 1.1 mi from the reactor. Dose is calculated at 1.1 mi from the reactor in the direction of maximum  $\chi/Q$  without decay (see ER Table 4.8-20), which was also the direction of maximum deposition.
- (d) The ingestion pathway at the site boundary does not include dairy production. There is no identified production of dairy products in the area of the site. The cultivation of vegetables and livestock for the ingestion pathways considered is assumed to occur at the location of the analytical nearest resident.

Source: (Kairos 2022-TN7882 | Table 4.8-22).

1   **Table 3-9 Annual Total Effective Dose Equivalent to the Individual Members of the Public**

Dose Receptor	Annual TEDE	Annual TEDE Dose Regulation Limits
<b>Gaseous Effluents</b>		
Site boundary	0.57 mrem (0.0057 mSv)	
MEI in an unrestricted area (0.5 mi)	1.4 mrem (0.014 mSv)	10 mrem(a) (0.1 mSv)
Nearest full-time resident	1.2 mrem (0.012 mSv)	
<b>Total Dose (Combined External Dose and Gaseous Effluent)</b>		
Site boundary	1.6 mrem (0.016 mSv)	
MEI in an unrestricted area (0.5 mi)	2.4 mrem (0.024 mSv)	100 mrem(b) (1.0 mSv)
Nearest full-time resident	1.3 mrem (0.013 mSv)	

Key: TEDE = total effective dose equivalent; mrem = millirem; mSv = millisievert; MEI = maximally exposed individual; mi = miles.

(a) 10 CFR 20.1101(d) (TN283) for airborne emissions.

(b) 10 CFR 20.1301(a)(1) (TN283) for licensed operations.

(c) Includes ingestion of meat and vegetable produced at the analytical nearest resident location.

(d) Dose is modeled at the distance of the analytical nearest resident but in the direction of the maximum deposition.

(e) The external dose was not modeled and is conservatively assumed to be 1 mrem/yr (Section 4.8.2.4.1).

Source: (Kairos 2021-TN7880 | Table 4.8-3).

2   **3.7.2.3.3 Radiological Environmental Monitoring**

3   Kairos discusses radiological environmental monitoring in accordance with 10 CFR 20.1302  
4   (TN283) in PSAR Section 11.1.7 and ER Section 4.8.3 to demonstrate compliance with the  
5   dose limits for individual members of the public in 10 CFR 20.1301 (Kairos 2021-TN7880).  
6   Kairos would implement a radiological environmental monitoring program to perform the  
7   necessary monitoring for assessing the following exposure pathways: direct radiation, airborne,  
8   waterborne, and ingestion. Monitoring sites would be determined prior to operation for onsite,  
9   site perimeter, and offsite locations considering the guidance followed by LWRs, namely RG 4.1  
10   (NRC 2009-TN3802) and NUREG-1301 (Kairos 2021-TN7880 | Sec 4.8.3.2).

11   To monitor the direct radiation pathway, Kairos would post thermoluminescent dosimeters at  
12   several locations onsite, at the site boundary, and at an offsite location to capture the  
13   background dose as a control measurement. Groundwater sampling would be established at  
14   locations based on the groundwater gradient where some existing East Tennessee Technology  
15   Park test wells could be used in support of the Hermes test reactor operations for addressing  
16   potential leaks and spills. Based on evaluated meteorological conditions and monitoring of the  
17   airborne exposure pathway, monitoring stations at three locations near the facility site boundary,  
18   a fourth air sampling location at a nearby community, and a fifth location farther away from the  
19   facility to provide background (i.e., control) readings, would be established. The ingestion  
20   exposure pathway would be established to monitor for deposition of PM onto edible produce in  
21   the vicinity of the facilities and specifically for the monitoring of milk, if being produced nearby.  
22   In the case of the East Tennessee Technology Park site, no dairy or goat milk production occurs  
23   within 5 mi, so milk sampling would only occur if such production were found to exist within the  
24   mentioned 5 mi.

25   The NRC staff will review the finalized monitoring locations and other monitoring requirements  
26   provided with the OL application. During the OL application phase, the NRC safety staff will  
27   determine whether the operational radiological environmental monitoring program will be

1 adequate for the evaluation of environmental impacts related to operating the Hermes test  
2 reactor at the East Tennessee Technology Park site.

3 *3.7.2.3.4 Conclusions*

4 The NRC staff performed an independent review of the radiological gaseous effluent releases  
5 and finds that the expected annual doses to members of the public as previously described are  
6 below the appropriate dose limits in 10 CFR Part 20 (TN283). Additionally, the NRC staff will  
7 perform an independent safety review of Kairos' plans for exposure control and radiological  
8 effluent monitoring and its compliance with applicable regulatory requirements of 10 CFR Part  
9 20, such as 10 CFR 20.1301 (TN283). The NRC staff's independent safety review will be  
10 documented in its Safety Evaluation Report. Based upon the discussion above and the staff's  
11 completion of a thorough independent safety review and evaluation of the applicant's  
12 information that states Kairos will comply with applicable requirements, the NRC staff concludes  
13 that the environmental impacts from radiological gaseous effluent releases would not be  
14 significant and further mitigation would not be warranted.

15 *3.7.2.4 Environmental Impacts of Decommissioning*

16 Upon cessation of operations, all radioactive material would be transferred to various types of  
17 storage containers based on the type of material (e.g., molten salts, spent TRU-structural  
18 ISOtropic [TRISO] fuel, and radioactive material from decontamination operations) and shipped  
19 to licensed disposal sites. While some trace amounts of tritium could be expected to diffuse out  
20 of such storage containers, radiation area monitoring would continue to ensure safe storage of  
21 the radioactive material until it is removed from the site or placed in a specifically designed and  
22 certified dry cask storage system, if necessary. The Decommissioning Generic Environmental  
23 Impact Statement (GEIS) discusses the expected radiological impacts that could occur during  
24 decommissioning of a large LWR (1,130 MWe pressurized water reactor or a 1,100 MWe boiling  
25 water reactor), including the appropriate practices to minimize radiological exposure to workers,  
26 and found that impacts would be small and that no additional mitigation measures are likely to  
27 be sufficiently beneficial to be warranted (NRC 2002-TN7254). The Hermes test reactor is a  
28 small fraction of a large LWR (35 MWt versus approximately 3,300 MWt LWR) and would have  
29 a proportionally small fraction of the radiological impacts discussed in the Decommissioning  
30 GEIS. Based on the small size of the Hermes test reactor and on the radiological impacts  
31 discussed in the Decommissioning GEIS, the staff concludes that Hermes radiological  
32 environmental impacts during decommissioning would be negligible.

33 *3.7.2.5 Cumulative Impacts*

34 Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
35 could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
36 TN7880). In addition to impacts from construction and operations, this cumulative analysis also  
37 considers other past, present, and reasonably foreseeable future actions that could contribute to  
38 cumulative radiological impacts. For the purposes of this analysis, the geographic area of  
39 interest is the area within a 50 mi radius of the Hermes site. The NRC staff finds this metric to  
40 be acceptable because historically the NRC has used the 50 mi radius as a standard bounding  
41 geographic area to evaluate population doses from routine releases from nuclear power plants  
42 (NPPs). This region contains several radiological projects or facilities. Within the geographic  
43 area of interest, reasonably foreseeable planned Federal projects on the ORR include the  
44 Sludge Processing Mock Test Facility at the Transuranic Waste Processing Center, the  
45 Uranium Processing Facility at the Y-12 Complex, and a new disposal area to replace the

1 DOE's Environmental Management Waste Management Facility. Other major currently  
2 operating ORR nuclear facilities include the High Flux Isotope Reactor, a nuclear research  
3 reactor located at ORNL, and the ORNL Spallation Neutron Source. Other radiological projects  
4 or facilities outside of ORR but within the geographic area of interest identified by Kairos in ER  
5 Table 4.13-1 include TVA's Watts Bar Units 1 and 2 (30 mi southwest), TVA's proposed CRN  
6 site (3.5 mi south-southeast), EnergySolutions Bear Creek Processing Facility, which processes  
7 low-level radioactive waste for permanent disposal (2 mi southeast), and the proposed Coquí  
8 Pharma medical isotope production facility (0.75 mi south) (Kairos 2021-TN7880 | Table 4.13-  
9 1). As identified in the CRN ESP final environmental impact statement, there is the former  
10 American Nuclear Corporation site, closed since 1970, where radioactive materials are being  
11 allowed to decay in place (NRC 2019-TN6136 | Table 7.1). These facilities have the potential to  
12 contribute to cumulative radiation exposures in conjunction with the Hermes test reactor.  
13 However, given the small radiological doses from the Hermes test reactor and the fact the  
14 radiation doses from facilities discussed in the above affected environment for this section have  
15 been shown to be low, the staff concludes that there would not be a noticeable increase in the  
16 cumulative radiological impacts of the above projects or facilities by the Hermes test reactor for  
17 the geographic area of interest.

18 **3.7.2.6 Conclusions**

19 The staff concludes that the potential direct, indirect, and cumulative radiological human health  
20 impacts of the proposed action during the 4 years of operation and during decommissioning,  
21 along with cumulative impacts would be SMALL. This conclusion is based primarily on the fact  
22 that the proposed Hermes test reactor is estimated to have radiological effluent releases well  
23 below the NRC requirements for potential doses to members of the public (e.g., the nearest  
24 resident) with appropriate radiological environmental monitoring and because occupational  
25 doses would be less than annual dose limits under 10 CFR Part 20 (TN283) regulations.

26 **3.8 Nonradiological Waste**

27 **3.8.1 Affected Environment**

28 Section 3.1 of this draft EIS Land Use and Visual Resources, provides a detailed physical  
29 description of the proposed Hermes site and its surrounding vicinity. Figures 3.1-2 and 3.1-3 of  
30 the applicant's ER provide maps detailing the current land use categories, including croplands,  
31 forested areas, and developed lands within the 5 mi region surrounding the site (Kairos 2021-  
32 TN7880). The proposed Hermes site is presently undeveloped, with portions used by DOE for  
33 construction laydown (Kairos 2021-TN7880 | Sec 3.1.1.1). There are no chemical plants,  
34 refineries, mining or quarrying facilities, or military facilities within 5 mi of the site (Kairos 2021-  
35 TN7880 | Sec 3.1.1.2). The applicant indicates there are no radioactive or hazardous materials  
36 currently stored on the site but acknowledges the potential for residual radioactive or hazardous  
37 contamination could be present at levels above background but below risk-based standards  
38 because the site was once the home of the K-31 and K-33 gaseous diffusion plants.  
39 Section 3.9 of this draft EIS discusses radiological waste management and the Uranium Fuel  
40 Cycle.

41 **3.8.2 Environmental Impacts of Construction**

42 Nonradiological waste hazards may arise from normal activities (emissions, discharges, and  
43 solid waste) during the construction phase of the proposed project, as well as from accidental  
44 releases in solid, liquid, or gaseous states. The applicant states all normal activity releases will

1 be managed in accordance with applicable Federal, State, and local laws and regulations and  
2 permit requirements (Kairos 2021-TN7880 | Sec 4.8.1).  
3 The applicant characterizes waste to be generated during construction in Section 4.9.1.1 of the  
4 ER (Kairos 2021-TN7880 | Sec 4.9.1.1). Solid nonradiological waste would include  
5 construction and demolition waste such as scrap lumber, bricks, sandblast grit, glass, wiring,  
6 non-asbestos insulation, roofing materials, building siding, scrap metal, concrete with reinforcing  
7 steel, and other similar materials (Kairos 2021-TN7880 | Sec 4.9.1.1). Typical liquid  
8 nonradiological waste produced during normal activities would include fuels, oils, solvents,  
9 paints and stains, and other chemicals. The most common liquid waste would be human waste,  
10 which would be discharged via municipal sewers to the Rarity Ridge Wastewater Treatment  
11 Facility (Kairos 2021-TN7880 | Sec 4.8.1.2.1). Other liquid chemicals would be treated onsite  
12 before shipment to the Rarity Ridge Wastewater Treatment Facility to ensure that the facility's  
13 requirements are met. The applicant estimates air emissions from the facility would fall below  
14 the 100 TPY threshold established by the TDEC for criteria pollutants (SO<sub>2</sub>, NOx, PM<sub>10</sub>, PM<sub>2.5</sub>,  
15 CO, VOCs, and Pb) during the projected two-year construction period (Kairos 2021-TN7880 |  
16 Sec 4.2.1.1). Management of solid waste would involve waste reduction efforts, recycling, and  
17 BMPs during all phases of the project.

### 18 **3.8.3 Environmental Impacts of Operation**

19 Although the applicant plans to register the facilities as a Small Quantity Generator under the  
20 Resource Conservation and Recovery Act (TN1281), it expects that there would be no  
21 significant sources of hazardous waste during operations (Kairos 2021-TN7880 | Sec 4.9.1.2).  
22 The applicant plans to manage any hazardous waste, including universal wastes, in accordance  
23 with a waste management plan that conforms with applicable Federal and State regulations  
24 (Kairos 2021-TN7880 | Sec 4.9.1.2). Operation of the reactor building would generate gaseous  
25 effluents, which would be passed through a high-efficiency particulate air filtration system prior  
26 to discharge through the ventilation stack (Kairos 2021-TN7880 | Sec 4.8.1.2.2). Solid waste  
27 from operations would include operations, maintenance, and demolition debris; food waste and  
28 food product packaging waste; and disposable office items. As stated in the applicant's ER,  
29 solid waste would be collected and stored temporarily onsite and either disposed of at a nearby  
30 sanitary site or recycled. Management of solid waste would involve waste reduction efforts,  
31 recycling, and BMPs (Kairos 2021-TN7880 | Sec 4.8.1.2.3). The facilities would not release  
32 nonradioactive liquid chemicals to the environment (Kairos 2021-TN7880 | Sec 4.8.1.4.2); and,  
33 as noted above in Section 3.3 of this draft EIS, wastewater discharges would be sent to a  
34 municipal WWTP for treatment.

### 35 **3.8.4 Environmental Impacts of Decommissioning**

36 The applicant plans to address waste management during decommissioning in a license  
37 termination plan prepared in accordance with NUREG-1757, *Consolidated Decommissioning*  
38 *Guidance*, Volumes 1-3, and submitted to the NRC for approval (Kairos 2021-TN7880 | Sec  
39 4.9.1.3). The NRC staff expects decommissioning to generate nonradiological solid waste  
40 materials such as building rubble and debris, concrete and structural materials, wood, glass,  
41 metals, gypsum and other finished materials, and office equipment, materials, and supplies.  
42 The NRC staff expects that the applicant would use BMPs to limit the amount of dust and other  
43 airborne particles. Liquid wastes from chemicals, solvents, and cleaning solutions would  
44 produce small amounts of volatilized chemicals, but BMPs would minimize their contribution to  
45 degradation of local air quality.

1    **3.8.5    Cumulative Impacts**

2    Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
3    could exacerbate the environmental impacts of the proposed action (Kairos 2021-TN7880). The  
4    NRC staff expects that each industrial facility in the surrounding area would comply with  
5    applicable EPA and State regulations to ensure proper disposal of nonradiological waste.  
6    Based on the NRC staff's analysis of potential nonradiological waste impacts from the Kairos  
7    Hermes facilities, the NRC staff expects that the facilities would not substantially contribute to  
8    waste impacts in the area, due to its relatively small size and operating staff.

9    **3.8.6    Conclusions**

10   The NRC staff reviewed the applicant's ER and performed its own independent assessment of  
11   the nonradiological waste management discussion through a combination of independent  
12   research and the review of other NRC EISs, including the 2019 NUREG-2226 (NRC 2019-  
13   TN6136), *Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River*  
14   *Nuclear Site*, a project located approximately 4 mi to the east of the proposed site. The staff  
15   finds the conclusions of the Hermes nonradiological waste component to be consistent with  
16   those of the CRN EIS and finds that during all three life-cycle phases of the proposed Hermes  
17   project, the nonradiological waste impact from liquid, gaseous, and solid wastes would be  
18   SMALL, and mitigation would not be needed for releases during normal activities. As long as  
19   proper training and management practices are maintained the potential for accidental releases  
20   and environmental impact of accidental releases would also be minimal.

21   **3.9    Uranium Fuel Cycle and Radiological Waste Management**

22   **3.9.1    Uranium Fuel Cycle**

23   As presented in 10 CFR 51.51(a) (TN250), a light-water-cooled nuclear power reactor can use  
24   Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for uranium fuel cycle  
25   environmental effects. While the Hermes reactor is not a light-water-cooled nuclear power  
26   reactor, Kairos will rely upon the same uranium fuel cycle addressed by Table S-3. Thus, this  
27   section presents the Hermes reactor's contribution to the environmental effects of the current  
28   uranium fuel cycle with respect to Table S-3.

29   The License Renewal (LR) GEIS, NUREG-1437 Revision 1, in Section 4.12.1.1, Uranium Fuel  
30   Cycle, describes the current state of the uranium fuel cycle for the current nuclear fleet and is  
31   incorporated by reference in this EIS (NRC 2013-TN2654). The LR GEIS denotes several  
32   technological changes in the various fuel cycle operations that reduce the uranium fuel cycle  
33   impacts shown in 10 CFR 51.51 (TN250), namely Table S-3, such as:

- 34   • in situ mining of uranium rather than open pit or deep mining;  
35   • use of more efficient isotopic enrichment processes through the gaseous centrifuge rather  
36   than the energy-intensive gaseous diffusion process; and  
37   • less use of coal-powered electrical generation.

38   Two aspects of the front end of the uranium fuel cycle are different for the Hermes reactors.  
39   First, the Hermes reactor is designed to use a maximum enrichment of 19.55 wt% uranium-235  
40   (Kairos 2021-TN7880 | Sec 2.3 and Sec 4.1.1.1). Uranium enriched to this level is known as  
41   High-Assay Low Enriched Uranium or HALEU. Additionally, the source of HALEU for the Kairos

1 TRISO fuel has not been finalized (Kairos 2021-TN7880 | Sec 4.1.1.1). Kairos is expecting  
2 approximately 0.93 metric tons of uranium (MTU) would be needed over the four-year licensed  
3 operating life (Kairos 2021-TN7879) compared to an average of 20 to 33 metric tons of uranium  
4 per year (MTU/yr) for the current LWRs. Thus, due to the much lower quantity of uranium  
5 needed, the impacts from uranium recovery and uranium conversion would be much less than  
6 the impacts presented in WASH-1248 (AEC 1974-TN23) and Table S-3 would still be bounding.  
7 Regarding the source of HALEU for the Hermes reactor, one potential source for the needed  
8 0.93 MTU would be from the DOE. The DOE is supporting efforts regarding availability of  
9 HALEU for civilian domestic research, development, demonstration, and commercial use in the  
10 United States to prevent reliance on Russia or other foreign suppliers to fuel the next generation  
11 of nuclear power (87 FR 71055-TN7945). At this time, Kairos expects that HALEU material  
12 would be provided by an external source (Kairos 2021-TN7880 | Sec 2.7.1).

13 The second aspect concerns the Kairos Hermes reactor fuel type, which is designed to use  
14 TRISO fuel, a type of fuel that is not used in large LWRs. The source of fresh TRISO fuel may  
15 be provided from existing manufacturers or from a TRISO fuel fabrication facility built by Kairos.  
16 The manufacturing process for the Kairos-designed TRISO fuel involves three major  
17 manufacturing phases: kernel manufacturing, coated particle manufacturing, and pebble  
18 manufacturing (Kairos 2021-TN7944). Kernel manufacturing converts triuranium octaoxide  
19 ( $U_3O_8$ ) powder into spherical uranium oxycarbide (UCO) kernels (a mixture of uranium dioxide  
20 [ $UO_2$ ], uranium carbide [UC], and uranium dicarbide [UC<sub>2</sub>] phases). Using chemical vapor  
21 deposition, multiple layers are added to the kernels. The final manufacturing phase is building  
22 the pebbles by pressing the kernels to a graphite core, adding a fuel-free outer matrix shell, with  
23 a final machining step. Because of the difference in chemical processes for TRISO fuel  
24 fabrication from the chemical processes described in Appendix E of WASH-1248 (AEC 1974-  
25 TN23), the Kairos TRISO manufacturing line would have fewer impacts because Kairos would  
26 employ a simpler process for converting uranium hexafluoride ( $UF_6$ ) to UCO; the mechanical  
27 processes of building the TRISO pebbles (Kairos 2021-TN7944) is less extensive than the  $UO_2$   
28 pellet process of pelletizing, sintering, grinding, and washing; and the 0.93 MTU going through  
29 the fuel fabrication process is less than the 900 MTU/yr as assessed in Appendix E of WASH-  
30 1248 (AEC 1974-TN23). Thus, Kairos's TRISO fuel fabrication process would have fewer  
31 impacts than a more traditional  $UO_2$  fuel fabrication process and Table S-3 would also be  
32 bounding for TRISO fuel fabrication.

33 Kairos has no plans for reprocessing spent TRISO fuel and would store the spent TRISO fuel  
34 onsite upon cessation of 4 years of operation until final disposition (Kairos 2021-TN7880 | Sec  
35 2.7.1). Kairos would have enough spent TRISO fuel storage capacity within the Reactor  
36 Building to support four years of licensed reactor operation (Kairos 2022-TN7882). While Kairos  
37 has no plans at this time to use an external dry storage system, if such a decision is made after  
38 the cessation of operations, approval for building and operating such a dry storage system on  
39 an external pad would need to be sought prior to implementation of such a spent TRISO fuel  
40 management plan. The NRC staff notes that the requirements in 10 CFR Part 72 (TN4884),  
41 "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level  
42 Radioactive Wastes, and Reactor-Related Greater Than Class C Waste," do not apply to non-  
43 power reactor spent fuel. Depending on other nuclear industry and DOE actions in the future,  
44 Kairos may be able to ship the spent TRISO fuel offsite for interim storage or disposal. As  
45 noted by Kairos in ER Sections 2.7 and 4.10.3.1 (Kairos 2021-TN7880), transportation of spent  
46 TRISO would be conducted in a transportation package that is certified by the NRC under  
47 10 CFR Part 71, which would meet NRC requirements and U.S. Department of Transportation  
48 regulations (TN301).

1 Kairos states in ER Section 4.9 that storage systems associated with continued storage of  
2 TRISO fuel would not be significantly different than those considered for LWR storage systems  
3 and "...the environmental impacts for continued storage of LWRs described in NUREG-2157  
4 are considered to bound any impacts of the Hermes fuel storage" (Kairos 2021-TN7880). The  
5 NRC staff notes that NUREG-2157 states the Fort Saint Vrain spent fuel continues to be stored  
6 at an NRC-licensed Independent Spent Fuel Storage Installations (ISFSI) in Platteville,  
7 Colorado, and is within the scope of the Continued Storage GEIS (NRC 2014-TN4117). Fort  
8 Saint Vrain used prismatic-block graphite fuel elements containing a form of TRISO fuel  
9 particles made from a mixture of the carbides of thorium and uranium (NWTRB 2020-TN7966,  
10 ORNL 2003-TN7950). These carbide particles of thorium and uranium were then coated with  
11 highly retentive coatings of pyrolytic carbon (C) and silicon carbide (SiC) to form the fuel  
12 particles, or kernels, much like the TRISO kernels by Kairos. These TRISO-like fuel kernels and  
13 a carbonaceous matrix were combined to form a bonded prismatic-block graphite fuel element  
14 for the Fort Saint Vrain reactor core. DOE has approximately 23 MTU of spent Fort Saint Vrain  
15 fuel in an NRC-licensed ISFSI (NWTRB 2020-TN7966). The Kairos Hermes fuel begins in a  
16 similar manner, with a UCO TRISO fuel kernel, but instead of being combined with a  
17 carbonaceous matrix, the TRISO fuel kernels are embedded in an annular shell surrounding an  
18 inner graphite core and then further coated with layers of pyrolytic C, SiC, and an outer pyrolytic  
19 C layer to form a TRISO pebble (Kairos 2021-TN7879). In Section 2.1.1.3 of NUREG-2157, the  
20 staff states that "[t]he Fort Saint Vrain spent fuel continues to be stored at an NRC-licensed  
21 ISFSI in Platteville, Colorado, and is within the scope of this GEIS" (NRC 2014-TN4117).  
22 Because the Kairos TRISO fuel is similar to the Fort Saint Vrain coated fuel kernels, Kairos  
23 would be managing a much smaller amount of spent fuel (0.93 MTU from Hermes versus  
24 23 MTU from Fort Saint Vrain), and the Fort Saint Vrain spent fuel is within the scope of the  
25 Continued Storage GEIS, the Kairos spent TRISO storage environmental impacts after  
26 cessation of operations would be bounded by the Continued Storage GEIS environmental  
27 impacts provided in NUREG-2157 Tables ES-3, ES-4, and ES-5 (NRC 2014-TN4117).

### 28   **3.9.2    Radiological Waste Management**

29 Liquid and solid radioactive waste-management systems would be used for collection,  
30 processing, packaging, and storage of the radioactive materials produced as byproducts during  
31 operation and decommissioning of the Hermes test reactor. Waste processing systems would  
32 be designed to meet the design objectives of 10 CFR Part 50 (TN249), "Domestic Licensing of  
33 Production and Utilization Facilities," and 10 CFR Part 20 (TN283), "Standards for Protection  
34 Against Radiation."

35 Kairos describes in ER Section 2.6.1 the Hermes test reactor waste systems to collect, process,  
36 store, monitor, and appropriately address the disposal of the radioactive waste. While not  
37 expecting to need a gaseous radioactive waste system (Kairos 2021-TN7880 | ER Table 2.6-1),  
38 ER Table 2.6-1 lists the estimated types and quantities of the other radioactive wastes to be  
39 generated and disposed of, and a majority of them are classified by Kairos as solid low-level  
40 radioactive waste (LLRW) (Kairos 2021-TN7880).

#### 41   **3.9.2.1    *Liquid Radiological Waste Management***

42 Because the Hermes reactor design does not depend on water cooling in any of the engineering  
43 systems, the only potential water-based liquid radiological waste would be from vent  
44 condensation, drains, and decontamination (Kairos 2021-TN7880 | Sec 2.6.1.1). Based in part  
45 on the fission product confinement capabilities of the TRISO fuel, the quantity and radiological  
46 content are expected to be low enough such that this waste stream could be released under

1 10 CFR 20.2003 to the WWTP as monitored and disposed of within the limits of 10 CFR 20  
2 (TN283), Appendix B, Table 3 (release limits to sewers), such as  $1 \times 10^{-2}$  micro-curies per milli-  
3 liter ( $\mu\text{Ci/mL}$ ) for tritium. Because the management of this radiological waste stream would be  
4 performed within the limits set in 10 CFR Part 20 (TN283), the environmental impacts on  
5 members of the public would be negligible over the 4 years of operation of the Hermes reactor.

6 The other liquid radiological waste stream involves molten salt wastes that would have their own  
7 individual radiological waste systems for the handling of Flibe. As noted in Section 3.7 of this  
8 draft EIS, Flibe molten salt generates relatively large quantities of tritium when exposed to  
9 neutrons. Thus, a major waste stream-based radiological hazard would be from tritium, along  
10 with some fission, transuranics, and activation products (Kairos 2021-TN7880 | Table 2.6-1). At  
11 the end of operations, the Flibe would be collected in containers, solidified as the salts cool  
12 during storage with a low radionuclide gamma activity such that radiation decomposition of the  
13 Flibe would not be of concern (Kairos 2022-TN7902). As discussed in Section 3.11 of this draft  
14 EIS, as much as approximately 40 tons (T) of Flibe would be shipped to a LLRW disposal site  
15 as Class B or C LLRW during decommissioning. The solidified Flibe could be classified as  
16 Class C LLRW due to the presence of the C-14 radionuclide at greater than 0.8 but less than  
17 8.0 curies per meter cubed ( $\text{Ci}/\text{m}^3$ ) along with other radionuclides being controlled by the  
18 technical specifications provided in PSAR Table 14.1.-1 (Kairos 2021-TN7879). The only  
19 commercial Class B and C LLRW disposal site is the Waste Control Specialist site west of  
20 Andrews, Texas. Since this liquid radiological waste stream would be solidified, contained,  
21 monitored, and safely stored onsite within shielded spaces inside the Reactor Building, the  
22 environmental impacts on members of the public would be negligible over the 4 years of  
23 operation.

24 **3.9.2.2 Solid Radiological Waste Management**

25 The solid radioactive waste system would manage typical nuclear facility operational wastes,  
26 originating as dry or wet wastes. The dry waste stream would contain the following  
27 contaminated items (Kairos 2021-TN7880 | Sec 2.6.1.2):

- 28 • personal protective equipment;  
29 • rags, paper, and paper towels;  
30 • plastic containers;  
31 • laboratory apparatus;  
32 • small parts and equipment;  
33 • tools; and  
34 • air filters.

35 Filters and sieves from the inert gas system, chemistry control system, and inert gas system  
36 oxygen and moisture absorbers would constitute the wet solid wastes (Kairos 2021-TN7880 |  
37 Sec 2.6.1.2). Both solid waste streams would be appropriately packaged for onsite storage and  
38 eventual shipping to a LLRW disposal site. Even though Hermes is a test reactor, these types  
39 of solid radioactive waste are similar to those generated at operational NPPs. The estimated  
40 annual amount of solid radioactive waste, or dry activated waste, expected to be generated by  
41 Hermes operation, namely less than 8,800 cubic feet ( $\text{ft}^3$ ) annually (Kairos 2021-TN7880 | Table  
42 2.6-1), would be less than the LLRW volume generated by an operational NPP, which is on  
43 average approximately 10,600  $\text{ft}^3/\text{yr}$  (NRC 2013-TN2654). The LR GEIS determined for

1 operational NPPs that the environmental impacts from this form of radiological waste  
2 management are small (NRC 2013-TN2654). Currently operating LLRW disposal facilities  
3 available to Kairos (i.e., Waste Control Specialist in Andrews County, Texas and  
4 EnergySolutions at Clive, Utah) have adequate capacity to accommodate the quantity of LLRW  
5 expected to be generated by the four year-operation of the Hermes test reactor (TCEQ 2020-  
6 TN7967, EnergySolutions 2016-TN7990). Thus, the associated radiological impacts on the  
7 environment from solid radioactive waste generated by Hermes operation would also be small.

8     3.9.2.3    *Tritium Waste Management*

9 To control tritium within the Kairos Hermes test reactor facility and to minimize the release of  
10 tritium to the surrounding environment, Kairos would install a tritium management system (TMS)  
11 for capturing tritium releases from the Flibe molten salt. As described in PSAR Section 9.1.3  
12 and discussed in ER Section 2.6.1.2.3, the TMS manages tritium generated in the reactor and  
13 provides for recovery and storage of tritium from various systems (Kairos 2021-TN7879 | PSAR  
14 Sec 9.1.3.1, ER Sec 2.6.1.2.3, and Figure 2.6-1). The TMS consists of three separate system  
15 components:

- 16     • an inert gas capture system for separating tritium from the argon gas flow that is provided as  
17        a noncorrosive cover gas to multiple locations in the reactor vessel;
- 18     • a primary heat rejection system capture system for tritium separation from dry air in the  
19        cover gas; and
- 20     • a reactor cavity tritium capture system for tritium separation from dry air in Reactor Building  
21        cells.

22 These systems use either metal hydride or molecular sieves to capture and hold the tritium.  
23 The process for accomplishing such separations is described in PSAR Section 9.1.3 for each  
24 capture system and is incorporated by reference in this EIS (Kairos 2021-TN7879). Once the  
25 metal hydride or molecular sieves become saturated, they would be replaced and appropriately  
26 stored in preparation for shipment to a LLRW disposal site. Since the expected concentration of  
27 tritium is greater than the 40 Ci/m<sup>3</sup> limit for Class A LLRW per 10 CFR 61.55(a)(4) (TN5452), the  
28 material would need to be disposed as Class B LLRW, and the Waste Control Specialist site  
29 near Andrew, Texas, can accept this form of LLRW from the Hermes test reactor (Kairos 2022-  
30 TN7902). While tritium is a commercially available radionuclide, Kairos has no current plans to  
31 sell the tritium captured by the TMS (TN7902).

32     3.9.2.4    *Spent TRISO Waste Management*

33 Section 9.3 of the PSAR provides a detailed description of the pebble handling and storage  
34 system (PHSS) and a description of PHSS operations is provided in Section 2.7.1 of the ER  
35 (Kairos 2021-TN7879, Kairos 2021-TN7880). Both sections are incorporated by reference in  
36 this EIS. The storage portion of the PHSS (i.e., a cooling pool and an air cooled storage bay)  
37 would be designed to meet multiple principal design criteria to ensure the safe handling and  
38 storage of spent TRISO fuel in sealed containers for occupational and public safety. After 4  
39 years of operation and reaching a burnup level of approximately 57 gigawatt-days per metric ton  
40 of uranium (GWd/MTU), Kairos could have approximately 155,200 spent TRISO pebbles to be  
41 stored in containers held in the storage portion of the PHSS (Kairos 2022-TN7902). Each  
42 container could hold approximately 1,900 to 2,100 spent TRISO fuel pebbles (Kairos 2021-  
43 TN7880). The PHSS air-cooled storage bay is sized to store all spent TRISO fuel in  
44 approximately 74 to 82 containers over the four-year licensing period. This process of

1 managing spent TRISO fuel during the operational licensing period is similar to spent fuel  
2 management at operating NPPs, namely it involves a cooling pool supplemented with dry  
3 storage using air cooling. Sections 3.11.1.2 and 4.11.1.2 of the LR GEIS, Revision 1 of  
4 NUREG-1437, discuss the onsite storage process and the environmental impacts of spent  
5 nuclear fuel for operating NPPs for storing in a specifically designed water-cooled spent fuel  
6 pool with subsequent dry cask storage (NRC 2013-TN2654). The LR GEIS concluded that the  
7 current and potential environmental impacts from spent fuel storage onsite at the current reactor  
8 sites have been studied extensively, are well understood, and the environmental impacts were  
9 found to be small. Given that the design of the Hermes reactor TRISO fuel has multiple barriers  
10 to the release of fission products, more so than spent fuel assemblies, the onsite storage  
11 systems are similar in function, the amount of MTU of spent TRISO fuel is far less than at an  
12 operational LWR, and process of managing spent TRISO fuel would be regulated in the same  
13 manner as at the current LWRs. The environmental impacts presented in the LR GEIS also  
14 apply to the onsite storage of spent TRISO fuel for the Hermes reactor.

15 **3.9.2.5 Gaseous Radiological Waste Management**

16 Kairos states in the PSAR and ER that there is no anticipated need for a gaseous radioactive  
17 waste system based on the use of the TMS, and no production, storage, or disposal of  
18 radioactive gaseous waste is expected. (Kairos 2021-TN7879 | Sec 11.2.2.1, Kairos 2021-  
19 TN7880 | Sec 2.6.1.3). Radioactive gases, such as tritium gas not captured by the TMS but  
20 diffused out of various materials, would be discharged to the Reactor Building heating,  
21 ventilation, and air conditioning system, where they pass through a high-efficiency particulate air  
22 filter and are monitored prior to release (Kairos 2021-TN7879 | Sec 11.2.3, Kairos 2021-TN7880  
23 | Sec 2.6.1.3). Impacts related to such gaseous releases of tritium during normal operations are  
24 addressed in Section 3.7 of this draft EIS.

25 **3.9.3 Conclusions**

26 The NRC staff concludes that the uranium fuel cycle impacts and radiological waste  
27 management impacts from operation and decommissioning of the Kairos Hermes reactor would  
28 be SMALL. This conclusion is based on the following:

- 29 • The relatively low quantity of uranium (0.93 MTU) to be used during the license period of  
30 four years is far less than the annual amount used to assess Table S-3 impacts.
- 31 • The TRISO fuel processes (i.e., HALEU enrichment and fuel fabrication) for the Hermes  
32 reactor are bounded by Table S-3 limits.
- 33 • The spent TRISO fuel environmental impacts from storage onsite or offsite upon cessation  
34 of operations are bounded by the Continued Storage GEIS.
- 35 • Any liquid or gaseous radiological waste stream releases would be in accordance with and  
36 within regulatory limits of 10 Part 20 (TN283).
- 37 • The estimated volume of LLRW from operation of the Hermes reactor would be comparable  
38 to or less than the LLRW volumes from an NPP; there is adequate capacity at LLRW  
39 disposal sites; and the waste form, especially the chemical form, is acceptable at a LLRW  
40 disposal site.

41 Based on the above, the onsite storage of spent TRISO fuel would be similar to current LWRs  
42 and must meet the same regulatory safety requirements.

1    **3.10 Transportation of Radioactive Material**

2    This section addresses the radiological and nonradiological environmental impacts from normal  
3    operating (radiological) and accident conditions (radiological and nonradiological) resulting from  
4    the shipment of unirradiated fuel to the East Tennessee Technology Park site, shipment of  
5    LLRW and mixed waste to offsite disposal facilities during operations, and shipment of spent  
6    fuel to an interim storage facility or a permanent geologic repository during decommissioning.  
7    For the purposes of these analyses, the NRC staff considered the proposed Yucca Mountain,  
8    Nevada, repository site as a surrogate destination for a monitored retrievable storage facility or  
9    permanent geologic repository.

10   **3.10.1 Environmental Impacts from Operation**

11   The NRC performed a generic analysis of the environmental effects of the transportation of fuel  
12   and waste to and from LWRs in the *Environmental Survey of Transportation of Radioactive*  
13   *Materials To and From Nuclear Power Plants* (AEC 1972-TN22) and in a supplement to WASH  
14   1238 (NRC 1975-TN216), and found the impact to be small. These documents summarize the  
15   environmental impacts of transportation of fuel and waste to and from one LWR of 3,000 to  
16   5,000 MWt (1,000 to 1,500 MWe). Impacts are provided for normal conditions of transport and  
17   accidents in transport for a reference 1,100 MWe LWR. Dose to transportation workers during  
18   normal transportation operations was estimated to result in a collective dose of 4 person-rem  
19   per reference reactor-year (RRY). The combined dose to the public along the route and the  
20   dose to onlookers were estimated to result in a collective dose of 3 person-rem per RRY.

21   In NUREG-0170, *Final Environmental Statement on the Transportation of Radioactive Material*  
22   *by Air and Other Modes* (NRC 1977-TN417, NRC 1977-TN6497), the NRC evaluated the  
23   shipment of radioactive material, including shipments of unirradiated fuel, spent nuclear fuel,  
24   and radioactive waste to and from NPPs. The NRC concluded in NUREG-0170 that the  
25   average radiation dose to the population at risk from normal transportation is a small fraction of  
26   the limits recommended for members of the general public from all sources of radiation other  
27   than natural and medical sources and is a small fraction of the natural background dose. In  
28   addition, the NRC determined that the radiological risk from accidents in transportation is small,  
29   amounting to about 0.5 percent of the normal transportation risk on an annual basis. The NRC  
30   also determined in NUREG-0170 that the environmental impacts of normal transportation of  
31   radioactive materials and the risks attendant to accidents involving radioactive material  
32   shipments are sufficiently small to allow continued shipments by all modes. The doses from  
33   radioactive waste accidents were negligible when compared to the doses from accidents  
34   involving spent fuel shipments. WASH-1238, NUREG-0170, and other LWR transportation  
35   assessments by the staff form the basis of assessment of the transportation of radioactive  
36   material to and from the Hermes test reactor.

37   **3.10.1.1 Fresh TRISO Fuel Shipments**

38   Over the life of the Hermes test reactor, a number of shipments of fresh TRISO fuel would  
39   periodically take place. Section 4.10.2.1 of the ER provides details about the uranium content  
40   of fresh TRISO pebbles, how many would be consumed on an annual and lifetime basis (38,800  
41   pebbles annually and 155,200 pebbles over 4 years), the type of existing transport packages  
42   that ship the fresh TRISO pebbles (Versa-Pac [VP]-55 or VP-110, manufactured by DAHER  
43   Group, Transport Logistics International, Inc.) (NRC 2021-TN7968), and the expected number  
44   of annual shipments using the VP-55 package to meet the needs of the Hermes test reactor  
45   operating at 35 MWth (three truck shipments per year) (Kairos 2022-TN7882).

1 As noted in Section 4.10.2.1 of the ER, a decision about the sourcing of fresh TRISO fuel has  
2 not been made at the time this EIS was published (Kairos 2021-TN7880). The source of fresh  
3 TRISO fuel may be provided by existing manufacturers or by a TRISO fuel fabrication facility  
4 built by Kairos, which could be near the Hermes test reactor on the East Tennessee Technology  
5 Park site (Kairos 2021-TN7880 | Sec 4.10.2.1 and Sec 4.13.1). Thus, the transportation  
6 impacts of fresh TRISO fuel could be negligible if the fuel fabrication facility is also located at the  
7 East Tennessee Technology Park site, or noticeable if the transportation distance could be  
8 significant if fuel is shipped from a distant nuclear fuel fabricator. Kairos elected for evaluation  
9 purposes in the ER to assume fresh TRISO fuel would be shipped by truck from the location of  
10 the farthest nuclear fuel manufacturer in the United States from the Hermes test reactor site,  
11 located in Richland, Washington (Kairos 2021-TN7880 | Sec 4.10.2.1). Based on an  
12 independent assessment, the NRC staff finds that shipments from such a location would bound  
13 the fresh TRISO fuel transportation impacts.

14 Normal conditions, sometimes referred to as “incident-free” transportation, are transportation  
15 activities during which shipments reach their destination without releasing any radioactive  
16 material to the environment (i.e., not being involved in a vehicular accident) (DOE 2002-TN418).  
17 Impacts from these shipments would be from the low levels of radiation that penetrate the  
18 shielding provided by unirradiated fuel shipping containers. Very low radiation exposures at  
19 some level would occur to the following individuals: (1) persons residing along the  
20 transportation corridors between the fuel fabrication facility and the Hermes site or alternative  
21 sites; (2) persons in vehicles traveling on the same route as an unirradiated fuel shipment;  
22 (3) persons present at vehicular stops for refueling, rest, and vehicle inspections; and  
23 (4) transportation crew workers. Calculations to estimate these low levels are completed with  
24 very conservative assumptions.

25 The NRC staff has performed a number of environmental evaluations of the shipment of fresh  
26 uranium fuel for LWRs operating at larger power levels than the Hermes test reactor. Incident-  
27 free, or normal operation, transportation impact analysis assumed the transportation package  
28 meets the regulatory maximum dose rate of 10 CFR 71.47 (TN301), “External radiation  
29 standards for all packages.” The accident analyses involving unirradiated fuel shipments  
30 accounted for radiological doses and nonradiological fatalities and injuries were due to the  
31 physical impacts of an accident. Staff reviewed the evaluation for the nearby Clinch River ESP  
32 final EIS, where environmental impacts of fresh uranium fuel shipment incident-free and  
33 accident impacts of an 800 MWe small modular reactor from Richland, Washington were  
34 discussed in Section 6.2 and found to be small (NRC 2019-TN6136)

35 Another Federal agency has also evaluated fresh TRISO fuel shipments. Specifically, the U.S.  
36 Department of Defense, acting through the Strategic Capabilities Office, has analyzed the  
37 transportation of high-activity low-enriched uranium TRISO fuels in VP-110 packages from  
38 Lynchburg, Virginia, to Idaho in the Project Pele mobile microreactor final EIS, published by  
39 DOE. This final EIS determined that the risks would be low based on 10 shipments from BWX  
40 Technologies, Inc. in Virginia to the Idaho National Laboratory site in Idaho (DOE 2022-TN7969  
41 | Table 4.12-4). Incident-free impacts were 1.3 person-rem to populations along the route  
42 (which can be large numbers of people receiving a small dose). The Project Pele microreactor  
43 final EIS predicted the accident risks related to fresh TRISO fuel shipments would only be  
44 approximately  $6 \times 10^{-9}$  latent cancer fatalities. Therefore, based on small impacts in the CRN  
45 ESP final EIS and DOE final EIS, the low level of radioactivity found in unirradiated enriched  
46 uranium no matter the form (i.e., LWR or TRISO fuel), and the fact that Kairos would only need  
47 three fresh TRISO fuel shipments per year (compared to 10 for Project Pele), the NRC staff

1 finds these prior transportation evaluations are applicable and demonstrate that the Kairos fresh  
2 TRISO fuel transportation impacts would be SMALL.

3    3.10.1.2 *LLRW Shipments*

4 Currently, four operating disposal facilities in the United States are licensed to accept LLRW  
5 from commercial facilities (NRC 2017-TN6518). They are located at Clive, Utah; Andrews  
6 County, Texas; Barnwell, South Carolina; and near Richland, Washington. The  
7 EnergySolutions disposal facility at Clive, Utah, is licensed by the State of Utah to accept Class  
8 A LLRW from all regions of the United States. The Waste Control Specialists, LLC (WCS) site  
9 in Andrews County, Texas, is licensed to accept Class A, B, and C LLRW from the Texas  
10 Compact generators (Texas and Vermont) and from outside generators with permission from  
11 the Texas Compact. EnergySolutions Barnwell Operations located near Barnwell, South  
12 Carolina, accepts waste from the Atlantic Compact states (Connecticut, New Jersey, and South  
13 Carolina) and is licensed by the State of South Carolina to dispose of Class A, B, and C LLRW.  
14 U.S. Ecology, located near Richland, Washington, accepts LLRW from the Northwest and  
15 Rocky Mountain Compact states (Washington, Alaska, Hawaii, Idaho, Montana, Oregon, Utah,  
16 Wyoming, Colorado, Nevada, and New Mexico) and is licensed by the State of Washington to  
17 dispose of Class A, B, and C waste. The two LLRW disposal sites that could accept LLRW  
18 shipments from Kairos Hermes facilities are the EnergySolutions disposal facility at Clive, Utah,  
19 accepting Class A LLRW and the WCS site in Andrews County, Texas for Class A, B, and C  
20 LLRW. In 2020, there was a total of approximately 1,010,300 ft<sup>3</sup> (28,610 cubic meter [m<sup>3</sup>]) of  
21 Class A LLRW shipped to both LLRW disposal sites and 2,050 ft<sup>3</sup> (58 m<sup>3</sup>) of Class B LLRW  
22 shipped to the WCS disposal site (DOE 2022-TN7991).

23 As provided in ER Table 2.6-1, Kairos estimates each year of operation could result in  
24 approximately 8,800 ft<sup>3</sup> (249 m<sup>3</sup>) of Class A LLRW to be shipped to either the EnergySolutions,  
25 Clive, Utah or the WCS LLRW sites and approximately 670 ft<sup>3</sup> (19 m<sup>3</sup>) of Class B LLRW to be  
26 shipped to the WCS LLRW disposal site (Kairos 2022-TN7882). This volume of LLRW from  
27 Hermes operation would be a small fraction of the annual shipments of Class A LLRW to either  
28 the EnergySolutions or the WCS LLRW disposal facilities or of Class B LLRW to the WCS  
29 LLRW disposal facility.

30 The NRC has previously evaluated the environmental impact of the transportation of radioactive  
31 materials on public roads and by air. The NRC concluded in 1977 that when radioactive  
32 material transportation is performed in compliance with all Federal regulations, the impact of  
33 such transportation is small (NRC 1977-TN417). The Commission determined that the  
34 environmental impacts, radiological and nonradiological, of normal (incident-free) transportation  
35 of radioactive materials and the risks and consequences of accidents involving radioactive  
36 material shipments in packages for which the NRC has issued design approvals meeting the  
37 performance standards of 10 CFR Part 71 were small (49 FR 9375-TN7951). Regulations,  
38 shipping practices, and package designs for transporting radioactive material have remained  
39 essentially unchanged since 1977. Since transportation performed in conjunction with operation  
40 of the Hermes facilities would be a small fraction of the annual volume of LLRW shipped to  
41 licensed disposal facilities and performed in compliance with U.S. Department of Transportation  
42 and NRC regulations, the NRC staff concludes that the impacts from transportation of LLRW  
43 during Kairos Hermes operation would be SMALL.

1    **3.10.2 Environmental Impacts from Decommissioning**

2    Spent TRISO fuel would be stored in the Reactor Building of the Hermes test reactor over the  
3    four-year life span of the facilities (Kairos 2022-TN7882). Following cessation of operations, the  
4    spent TRISO fuel would have to be further stored at the East Tennessee Technology Park site  
5    or shipped offsite to an interim storage facility or a permanent geologic repository. There would  
6    also be quantities of LLRW to be addressed during decommissioning for disposal at one or  
7    more commercial LLRW disposal sites in the same manner as previously discussed during the  
8    operational lifetime of the Hermes test reactor.

9    For decommissioning of the Hermes test reactor, options for addressing the spent TRISO fuel  
10   could be maintaining the spent fuel in a separate storage facility at the East Tennessee  
11   Technology Park site or shipping the spent fuel to an interim storage facility or a permanent  
12   geologic repository. The NRC has licensed one interim storage facility (NRC 2021- Interim  
13   Storage Partners reference below (ML21188A096)), but the distance to the once-proposed  
14   Yucca Mountain geologic repository is greater and is the disposal location that Kairos selected  
15   for analysis. Based on an independent assessment, the NRC staff finds shipping to this location  
16   would have larger impacts than shipping to a licensed interim storage facility.

17   The NRC staff has extensively analyzed shipments of spent LWR fuel in a number of new  
18   reactor licensing reviews to the once-proposed Yucca Mountain and for three away-from-reactor  
19   interim storage facility licensing reviews (i.e., Private Fuel Storage Facility, Holtec International  
20   Consolidated Interim Storage Facility, and the Interim Storage Partners Consolidated Interim  
21   Storage Facility). Prior NRC transportation analyses of spent LWR fuel environmental impacts  
22   in support of license renewal for burnup levels up to 62 GWd/MTU<sup>1</sup> were found to still be  
23   bounded by Table S-4 of 10 CFR 51.52 (TN250), as documented in NUREG-1437, Revision 1,  
24   the LR GEIS (NRC 2013-TN2654). The staff also assessed LWR spent fuel shipments in  
25   NUREG-2125, which demonstrate that the NRC regulations continue to provide adequate  
26   protection of public health and safety during the transportation of spent nuclear fuel (NRC 2014-  
27   TN3231).

28   Regarding the number of spent TRISO shipments during decommissioning, Kairos would need  
29   to package and ship up to 155,200 irradiated, or spent, TRISO pebbles after 4 years of Hermes  
30   operation (Kairos 2022-TN7882). As noted in Section 3.9 of this draft EIS, a spent TRISO fuel  
31   container could hold 1,900 to 2,100 spent TRISO pebbles. Thus, Kairos could have  
32   approximately 74 to 82 containers to be shipped to a disposal site during decommissioning.  
33   A modified NAC International Inc. legal weight certified truck package holding two sealed spent  
34   TRISO canisters may be used because this transportation package has been certified for and  
35   used in other spent fuel shipments (Kairos 2022-TN7902). This would result in up to 41 spent  
36   TRISO shipments. For comparison purposes, the analysis used to support Table S-4 assumed  
37   60 normalized annual spent LWR shipments. The CRN ESP final EIS transportation analysis  
38   assessed 137 normalized annual spent LWR shipments to the once-proposed Yucca Mountain  
39   geologic repository (NRC 2019-TN6136 | Table 6-10). Therefore, the CRN ESP final EIS  
40   transportation analysis is conservative and will be applied to bound the impacts of the expected  
41   spent TRISO shipments during decommissioning of the Hermes test reactor.

42   As discussed for fresh TRISO fuel shipments in the above environmental impacts from  
43   operation, incident-free impacts from the shipment of spent TRISO fuel is determined based on  
44   the assumption that the transportation package meets the regulatory maximum dose rate of

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<sup>1</sup> Burnup level is a good indicator of the radionuclide inventory quantity contained in spent nuclear fuel.

1    10 CFR 71.47 (TN301). For this analysis, the NRC staff is also applying the same assumption  
2    provided in the CRN ESP final EIS for spent TRISO fuel shipments, namely that the once-  
3    proposed Yucca Mountain geologic repository is a surrogate disposal location for bounding  
4    these impacts. As such, with the number of spent TRISO fuel truck shipments being less than  
5    the number assessed in the CRN ESP final EIS Section 6.2, both the incident-free and the  
6    nonradiological accident impacts of the Hermes test reactor spent TRISO shipments are  
7    bounded by the results in the CRN ESP final EIS and impacts would be SMALL.

8    For consideration of the radiological impacts from potential transportation accidents, the  
9    structure of TRISO is such that multiple barriers associated with the TRISO kernels and pebbles  
10   must be broken before a release of radioactive material from a shipping package could become  
11   possible. As discussed in Section 3.9 of this EIS, after reaching a burnup level of approximately  
12   57 GWd/MTU, Kairos would place the spent TRISO pebbles into sealed canisters for storage  
13   during operation. Additionally, the structure of the types of sealed canister into which spent  
14   TRISO pebbles would be placed would provide added levels of robustness, or an additional  
15   defense-in-depth layer than already provided by the coated TRISO particles and the coated  
16   TRISO pebbles, for withstanding physical impacts beyond the thin-walled single barrier offered  
17   by the fuel pin for LWR spent fuel assembly shipments. Based on structural and thermal  
18   analyses, NUREG-2125, *Spent Fuel Transportation Risk Assessment*, showed that spent fuel  
19   within an inner welded canister in the shipping package (referred to in NUREG-2125 as  
20   canistered fuel) does not rupture even under the most severe accidents analyzed, so no  
21   radioactive material would exit the cask (NRC 2014-TN3231 | Sec E.4.3). Thus, the type of  
22   spent fuel shipping packaging being proposed by Kairos would be very similar in performance to  
23   the canistered fuel analyzed in NUREG-2125 and therefore can be expected to provide similar  
24   levels of protection.

25   For a significant release of radioactive material to occur as the result of a transportation  
26   accident that could breach the shipping package, a very large number of spent TRISO kernels  
27   must have their coatings cracked within a given number of TRISO pebbles, which also must  
28   have significant cracking of their pebble coatings. The internal pressure in the TRISO kernels  
29   must then be enough to move the fission products and transuranic elements out of the kernel,  
30   into the annular region of each pebble and out through the cracks in the TRISO pebbles into the  
31   inner spaces of the TRISO containers. The TRISO containers, with their more significant  
32   structure than an irradiated LWR fuel pin, must also be broken to allow the radioactive material  
33   to enter the inner volume of the shipping package and then out through the breach of that final  
34   barrier. Therefore, because of the nature of the differences in the number of barriers that must  
35   be broken for a release of radioactive material from a spent TRISO shipment versus a spent  
36   LWR fuel assembly shipment, it would be more difficult for a transportation accident involving  
37   spent TRISO to have the same environmental impact from accidents involving spent LWR fuel  
38   assembly shipments. Thus, the prior small impacts of spent LWR fuel assembly shipments  
39   transportation accidents provided in the CRN ESP final EIS (which had impacts of SMALL)  
40   would bound the spent TRISO shipments transportation accidents.

41   Decommissioning activities would also address disposal of all remaining LLRW with shipments  
42   to licensed LLRW disposal facilities. Outside of contaminated systems, structures, and  
43   components, such as the reactor vessel and TRISO handling equipment, the same LLRW  
44   generated during operations would be present at the time of cessation of operations and would  
45   be handled and shipped to LLRW disposal sites in the same manner as previously described,  
46   such as the tritium capture materials and dry active wastes as Class A and B LLRW. For the  
47   Flibe molten salt, this material would be classified and disposed as either Class B and  
48   potentially Class C LLRW, as set by the concentration of tritium and other radionuclides in the

1 Flibe and as controlled by the Hermes technical specifications of PSAR Table 14.1-1. Kairos is  
2 expected to have up to approximately 40 T of Flibe to dispose of during decommissioning,  
3 which would translate to between 16 and 20 m<sup>3</sup> of material (Kairos 2022-TN7902). The total  
4 amount of Class B and Class C LLRW shipped to WCS from all sources varies between 150 to  
5 350 m<sup>3</sup>. Thus, the amount of Flibe material to be disposed of is a small fraction of what WCS  
6 receives in a given year. Additionally, Kairos confirmed that this material is acceptable in all  
7 aspects for disposal at the WCS facility (TN7902). Thus, as is noted for LLRW shipments  
8 during operations, since this volume of material is a small fraction of the total annual volume of  
9 LLRW shipped to licensed disposal facilities and performed in compliance with U.S. Department  
10 of Transportation and NRC regulations, the NRC staff concludes that the impacts from  
11 transportation of Flibe during Kairos Hermes decommissioning would be SMALL.

12 The impacts associated with transporting equipment and materials (radiological and  
13 nonradiological) offsite during decommissioning of a LWR are analyzed in Section 4.3.17 of the  
14 Decommissioning GEIS and are found to be small (NRC 2002-TN665). As is the case for  
15 LWRs, the materials transported offsite would include all contaminated wastes generated onsite  
16 from deconstruction of the Hermes facilities. Radiological impacts would include exposure of  
17 transportation workers and the general public along the transportation routes. Nonradiological  
18 impacts would include increased traffic volume, additional wear and tear on roadways, and  
19 potential traffic accidents. It was concluded that the transportation impacts would not be  
20 destabilizing. The Hermes facilities are significantly smaller than the LWR evaluated in the  
21 Decommissioning GEIS and would have less contaminated material to be shipped to LLRW  
22 disposal sites. The nonradiological decommissioning transportation impacts would also be less  
23 than those presented in the Decommissioning GEIS due to the smaller size of the Hermes  
24 facility. Therefore, the potential transportation impacts during decommissioning of the Hermes  
25 facilities would also be SMALL.

### 26 **3.10.3 Conclusions**

27 Based the quantity of nuclear material and waste, the material form would be acceptable for  
28 disposal, and would employ certified transport packages in accordance with NRC and DOT  
29 regulations, the NRC staff concludes that the transportation of fuel and waste impacts from  
30 operation and decommissioning of the Hermes reactor would be SMALL.

## 31 **3.11 Postulated Accidents**

### 32 **3.11.1 Environmental Impacts of Operation**

33 This section discusses the potential offsite radiological consequences of the Maximum  
34 Hypothetical Accident (MHA) that could only occur during operations. The results of the  
35 analysis are compared to the NRC's dose reference values for test reactor siting given in  
36 10 CFR 100.11 (TN282), "Determination of exclusion area, LPZ, and population center  
37 distance." The MHA is a conservative evaluation and represents the bounding consequences  
38 for potential design basis accidents (DBAs) at Kairos' proposed Hermes facilities.

39 The MHA is an event that could result in radiological consequences exceeding those of any  
40 credible accident. It is a bounding calculation of the radiological consequences of postulated  
41 DBAs at the proposed Hermes facilities. The MHA is based on events unique to the design of  
42 the proposed Hermes facilities that hypothetically could release radioactive materials into the  
43 environment. Kairos provides an analysis of postulated accidents and the resulting MHA doses  
44 in PSAR Chapter 13 (Kairos 2021-TN7879). A summary of the postulated events and  
45 consequences, consistent with PSAR Chapter 13, is provided in ER Section 4.11 (Kairos 2021-  
46 TN7880).

1 The NRC staff is conducting a thorough independent review of the safety-related structures,  
2 systems, and components, which it will document in its Safety Evaluation Report. The NRC  
3 staff will determine whether the safety-related structures, systems, and components will be  
4 designed, implemented, and maintained to ensure that they are available and reliable to perform  
5 their preventive or mitigative functions when needed so that the likelihood of serious  
6 consequences is small. If the NRC staff determines, in its SER, that Kairos has met all of the  
7 NRC regulatory requirements described above in order to clearly demonstrate that the Hermes  
8 test reactor would meet the regulatory standard of demonstrating adequate protection of public  
9 health and safety, then the likelihood of accidents would be reliably controlled.

10 The calculated dose of 227 mrem (2.27 mSv) as shown in Table 4.11-1 of the ER, as  
11 supplemented for the MHA at the proposed Hermes facilities' exclusion Area Boundary (EAB) at  
12 a distance of 250 meters (m), would be significantly below the whole body total radiation dose  
13 reference value of 25 rem (250 mSv) for two-hours immediately following onset of the release  
14 specified for DBAs in 10 CFR 100.11(a)(1) (Kairos 2021-TN7880, Kairos 2022-TN7883). While  
15 at the LPZ distance of 800 m, the MHA dose of 59 mrem (0.59 mSv) would be well below the  
16 dose reference values specified for DBAs in 10 CFR 100.11(a)(2) (TN282) and within the  
17 annual TEDE limit of 100 mrem (1.0 mSv) in 10 CFR 20.1301(a) (Kairos 2021-TN7880, Kairos  
18 2022-TN7883). The respective thyroid doses are also significantly below the dose criterion of  
19 300 rem as specified in 10 CFR 100.11(a)(1) and 100.11(a)(2) (TN282) for both locations. The  
20 dominant contributors to the MHA whole body and thyroid doses, both at the EAB and in the  
21 LPZ, are from gaseous radionuclides (Kairos 2022-TN7902). Since the nearest resident is  
22 located approximately 1,770 m (1.1 mi) from the site (Kairos 2022-TN7902) and the release is  
23 predominately gaseous, dispersion of the release between 800 m and 1,127 m would reduce  
24 the airborne concentrations, resulting in a lower dose at this location than the 59 mrem at the  
25 LPZ distance. Thus, the dose at the LPZ distance would bound any dose received offsite by the  
26 nearest resident or any other member of the public further away from the site.

27 Based on an independent safety review and a detailed evaluation of the applicant's information,  
28 the NRC staff must determine whether the applicant appropriately evaluated the potential  
29 events, including the radiological consequences of unplanned releases, that are relevant for the  
30 Hermes test reactor. The detailed results of the NRC staff's safety review for accidents will be  
31 available for public inspection in the Safety Evaluation Report at a future date.

32 As indicated in the previous discussion, an independent evaluation of the applicant's information  
33 by the NRC staff found the MHA doses at the EAB and the LPZ are below the reference doses  
34 required in 10 CFR 100.11 (TN282). Therefore, the NRC staff concludes that the environmental  
35 impacts from potential radiological accidents would be SMALL and further mitigation would not  
36 be warranted. Additionally, as an indicator of the low risks from postulated accidents, the MHA  
37 dose at the LPZ is also below the annual radiation dose limits for individual members of the  
38 public of 100 mrem TEDE under 10 CFR 20.1301(a) (TN283).

### 39 **3.11.2 Cumulative Impacts**

40 Table 4.13-1 of the ER identifies past, present, and reasonably foreseeable future projects that  
41 could cumulatively contribute to the environmental impacts of the proposed action (Kairos 2021-  
42 TN7880). The cumulative analysis considers risk from potential severe accidents at all other  
43 existing and proposed nuclear facilities that have the potential to increase risks at any location  
44 within 50 mi of the Hermes site. The 50 mi radius as the geographic area of interest was  
45 selected to encompass the magnitude and nature of expected impacts of the proposed activity,  
46 such as to cover any potential radiological release overlaps from two or more nearby nuclear

1 facilities. Key past and present actions affecting land resources in the affected area include  
2 Sequoyah Units 1 and 2, Watts Bar Units 1 and 2, and DOE facilities on the ORR, such as Y-12.  
3 As discussed in the CRN ESP final EIS Section 7.10 (NRC 2019-TN6136), which analyzed the  
4 environmental impacts of building and operating two small modular reactors at a site in close  
5 proximity to the Hermes site, the cumulative impacts of a reactor larger than the Hermes test  
6 reactor when considered along with these same facilities were found to be SMALL. Given the  
7 small doses from any postulated accident from the Hermes reactor, the lower power level, and  
8 the prior cumulative analysis for the CRN ESP, the NRC staff concludes that the cumulative  
9 risks of severe accidents at any location within 50 mi of the Hermes site likely would not be  
10 significant, and further mitigation would not be warranted.

### 11 **3.11.3 Conclusions**

12 The NRC staff concludes that the potential direct, indirect, and cumulative postulated accident  
13 impacts of the proposed action would be SMALL. This conclusion is based primarily on the fact  
14 that the proposed Hermes test reactor must meet the NRC requirements for postulated  
15 accidents where potential doses at the EAB and in the LPZ are below the dose reference values  
16 of 10 CFR Part 100 (TN282) for test reactor siting. The potential doses, as determined by  
17 Kairos, meet the requirements of 10 CFR 100.11 (TN282) and therefore demonstrate adequate  
18 protection of the public health and safety. Additionally, as another indication of the low level of  
19 environmental impacts, the nearest resident dose from accidents is also below the radiation  
20 dose limits for individual members of the public in 10 CFR 20.1301(a) (TN283).

### 21 **3.12 Climate Change**

22 The NRC staff has determined that it is reasonably foreseeable that climate change may alter  
23 the affected environment described in this section. Climate change is a global phenomenon  
24 that the construction, operation, and decommissioning of the proposed Hermes facilities would  
25 not appreciably alter. However, climate change could provide a new environment that may  
26 result in changed impacts from the proposed Hermes project. The NRC previously analyzed the  
27 potential changes to the Oak Ridge region as a result of climate change as part of the CRN ESP  
28 final EIS, in Appendix L of that document (NRC 2019-TN6136). That appendix presented the  
29 NRC staff's assessment of the potential effects of climate change on its evaluation of the  
30 environmental impacts of the proposed action for the CRN ESP and is summarized in the  
31 paragraph below.

32 The appendix in the CRN ESP final EIS has three sections: (1) description of the assessment  
33 process, (2) potential climate change impacts in the region, and (3) assessment summary (NRC  
34 2019-TN6136). The NRC considered the 2014, 2017, and 2018 U.S. Global Change Research  
35 Program (GCRP) reports when developing the analysis (USGCRP 2014-TN3472, USGCRP  
36 2017-TN5848, USGCRP 2018-TN5847), and no new GCRP reports have been issued since  
37 2018. The analysis considered the GCRP projections for the 2071–2099 period to be bounding  
38 for assessing the effects of climate change for the CRN project (NRC 2019-TN6136). The  
39 potential changes in the region as a result of climate change are discussed in Section L.3 (NRC  
40 2019-TN6136). The following resource areas were analyzed in the assessment: land use,  
41 hydrology, terrestrial and wetland ecology, aquatic ecology, socioeconomics, environmental  
42 justice, historic and cultural resources, meteorology and air quality, nonradiological health,  
43 radiological impacts, nonradioactive waste, accidents, and transportation of radiological  
44 materials. For all the resource areas considered, the analysis concluded there would be no  
45 change in the construction and operation impact conclusions of the CRN project proposed  
46 action as a result of climate change (NRC 2019-TN6136).

1 Because of the proximity of the proposed Hermes facilities to the CRN site, the potential  
2 changes in the region as a result of climate change can be expected to be the same for both the  
3 Clinch river proposed small modular reactors site and the proposed Hermes site. The NRC staff  
4 adopts the analysis from the CRN ESP EIS (NRC 2019-TN6136) for purposes of evaluating  
5 climate effects on the Hermes project. Additionally, the proposed Hermes facilities are much  
6 smaller with smaller magnitudes of impact, and use of the analysis in the CRN ESP EIS is  
7 further considered conservative because the proposed Hermes facilities are anticipated to  
8 operate for only 4 years compared to the 60 years analyzed for CRN (20 years for the ESP and  
9 40 years for the combined license). Therefore, the potential changes to the affected  
10 environment analyzed in the CRN ESP EIS would not be fully realized during the anticipated  
11 operation of the proposed Hermes facilities, and the staff concludes that none of the impact  
12 conclusions in this draft EIS for the Hermes facilities would change as a result of climate  
13 change.



## 4.0 ALTERNATIVES

2 This section describes alternatives to granting a construction permit for the proposed Hermes  
3 test reactor and the environmental impacts of those alternatives. The need to compare the  
4 proposed action with alternatives arises from the requirement in Section 102(2)(C)(iii) of the  
5 National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code  
6 [U.S.C.] 4321 et seq. TN661). NEPA states that an environmental impact statement (EIS) shall  
7 include an analysis of alternatives to the proposed action. The U.S. Nuclear Regulatory  
8 Commission (NRC) implements this requirement through regulations in Title 10 of the *Code of*  
9 *Federal Regulations* Part 51 (TN250) and in the Interim Staff Guidance to NUREG-1537 (NRC  
10 2012-TN5527, NRC 2012-TN5528), which state that the EIS will include an analysis that  
11 considers and weighs the environmental effects of the proposed action, the environmental  
12 impacts of alternatives to the proposed action, and alternatives available for reducing or  
13 avoiding adverse environmental effects.

14 For the licensing of non-power reactors, the NRC staff considers a no-action alternative and a  
15 range of reasonable alternatives that may include alternative sites, alternative layouts of  
16 proposed facilities within a site, modification of existing facilities instead of building new  
17 facilities, alternative technologies, and alternative transportation methods (NRC 2012-TN5527,  
18 NRC 2012-TN5528). The applicant followed a systematic process for identifying a range of  
19 reasonable alternative sites for the proposed Hermes project, as outlined in Sections 5.2 and  
20 5.3 of the Environmental Report (ER) (Kairos 2021-TN7880). The process involved systematic  
21 consideration of possible sites, leading to identification of two reasonable sites: the proposed  
22 site in the East Tennessee Technology Park in Oak Ridge, Tennessee, and an alternative site in  
23 Eagle Rock, Idaho. The applicant did not consider alternative layouts of the proposed facilities  
24 on either site. Land disturbance on the proposed site in Oak Ridge would be limited to lands  
25 previously disturbed by the former Oak Ridge Gaseous Diffusion Plant (ORGDP). Furthermore,  
26 the proposed site at the Oak Ridge site is situated in an existing industrial park already served  
27 by existing roadways and other infrastructure. Hence, consideration of other sites in the Oak  
28 Ridge area, or alternative layouts of the new buildings within the proposed site in Oak Ridge, do  
29 not offer opportunities to reduce environmental impacts. The Eagle Rock site is a large tract of  
30 relatively uniform undeveloped rangeland and cropland (Kairos 2021-TN7880 | Sec 5.4.1.1.1)  
31 without wetlands or surface water features (Kairos 2021-TN7880 | Sec 5.4.1.5.3). There are  
32 many possible layouts for the proposed facilities within the site, but none would substantially  
33 differ with respect to environmental impacts. Because neither site presently contains existing  
34 facilities, the applicant did not consider opportunities to repurpose existing facilities in lieu of  
35 building new facilities.

36 Because the purpose of the Hermes project is to demonstrate and test specific new  
37 technologies, specifically the Kairos Power Fluoride Salt-Cooled High Temperature Reactor  
38 (KP-FHR) technologies, the applicant did not consider alternative technologies for the Hermes  
39 reactor (Kairos 2021-TN7880 | Sec 5.3). The Hermes project does not require building offsite  
40 transmission lines, pipelines, or access roads, so the applicant did not identify proposed or  
41 alternative rights-of-way to serve either site. The applicant stated that transportation  
42 alternatives to the proposed site are limited to using existing road and rail facilities already  
43 servicing the East Tennessee Technology Park, which are adequate for the new facility (Kairos  
44 2021-TN7880 | Sec 5.3). The Eagle Rock site is served only by roads and is not served by  
45 resources capable of supporting alternative transportation such as waterways or railroads  
46 (Kairos 2021-TN7880 | Sec 5.4.1.7.1).

1 The NRC staff evaluated the applicant's process for identifying reasonable alternatives to the  
2 proposed action and finds, as described below, the applicant's process to be reasonable. The  
3 staff finds that the applicant's process is analytical, logical, appropriate to the purpose and need  
4 identified in Section 1.0 of this draft EIS, and in keeping with the spirit and intent for identifying a  
5 range of reasonable alternatives for analysis in an EIS. Section 4.1 below addresses the  
6 environmental impacts from a no action alternative; and Section 4.2 addresses the potential  
7 alternative sites for the Hermes project, including environmental impacts from the Eagle Rock  
8 site.

9 **4.1 No-Action Alternative**

10 Under the no action alternative, the NRC would not issue a construction permit to Kairos Power,  
11 LLC (Kairos) to build a test reactor to demonstrate the KP-FHR technology. The applicant could  
12 not build the proposed Hermes reactor and would therefore not have an opportunity to test the  
13 KP-FHR technologies, design features, and safety functions at a reduced scale relative to an  
14 anticipated commercial power reactor (Kairos 2021-TN7880 | Sec 5.1). While forgoing the  
15 opportunities provided by Hermes might not necessarily preclude future development of  
16 reactors using the KP-FHR technologies, it could slow or impede safe and efficient development  
17 of the technology. None of the environmental effects described in Section 3.0 of this draft EIS  
18 would occur under the no action alternative. But because Section 3.0 characterizes all potential  
19 environmental impacts of the proposed action as SMALL, any environmental benefits from  
20 selecting the no action alternative instead of the proposed action would be minimal.  
21 Additionally, under the no action alternative, the proposed site would remain available for other  
22 government or private industrial development projects, and many of the environmental impacts  
23 resulting from land disturbance and building new industrial facilities on the site might still occur  
24 at some time in the future.

25 **4.2 Site Alternatives**

26 The NRC staff identified one site alternative for detailed evaluation based on the applicant's ER  
27 and other information provided by the applicant. This alternative site, termed the Eagle Rock  
28 site, is situated approximately 20 miles (mi) west of Idaho Falls, Idaho, on federally owned  
29 property in eastern Idaho. Figure 5.4-1 of the ER (Kairos 2021-TN7880) depicts the location of  
30 the Eagle Rock site and its proximity to the City of Idaho Falls and tracts of nearby Federal land  
31 managed by U.S. Department of Energy (DOE) and other agencies. As reported in Section 5.4  
32 of the ER (Kairos 2021-TN7880), the applicant identified the Eagle Rock site as the only  
33 reasonable alternative site warranting detailed evaluation. The NRC staff reviewed the  
34 applicant's process for screening potential sites, outlined in Sections 5.3.1 and 5.3.2 of the ER  
35 (Kairos 2021-TN7880). The staff finds that the applicant used a logical approach to identify the  
36 range of reasonable alternative sites meeting the purpose and need of the Hermes project.  
37 Section 4.2.1 below summarizes the applicant's process; while Section 4.2.2 summarizes the  
38 potential environmental impacts of constructing, operating, and decommissioning the Hermes  
39 project at the Eagle Rock site.

40 **4.2.1 Process for Identifying Reasonable Alternative Sites**

41 The applicant followed the process described in Section 5.3.1 of the ER to evaluate potential  
42 sites for the proposed facilities (Kairos 2021-TN7880). The process follows the outline  
43 presented by the Electric Power Research Institute (EPRI) in *Advanced Nuclear Technology:  
44 Site Selection and Evaluation Criteria for New Nuclear Power Generation Facilities* (EPRI 2015-  
45 TN5285). This process involves defining a region of interest (ROI) and candidate areas within

1 the ROI, identifying specific candidate sites for evaluation and scoring, and finally selecting sites  
2 for detailed evaluation (Kairos 2021-TN7880 | Sec 5.3.1). The applicant conducted the process  
3 using reconnaissance-level data available in the public domain with limited consultation of  
4 stakeholders (Kairos 2021-TN7880 | Sec 5.3.1).

5 The results of the applicant's siting process are summarized in Section 5.3.2 of the ER (Kairos  
6 2021-TN7880). The applicant's ROI consisted of the continental United States, based on a  
7 preference for future deployment in geographic regions with a strong nexus to future domestic  
8 power markets and on the fact that the applicant does not have a specific service territory  
9 (Kairos 2021-TN7880 | Sec 5.3.2). Key site screening criteria used by the applicant included  
10 the availability of high-quality site data to support licensing and design, proximity to a national  
11 laboratory capable of supporting test plans, and connectivity to the targeted commercial reactor  
12 market (Kairos 2021-TN7880 | Sec 5.3.2). As presented in Table 5.3-1 of the ER, the applicant  
13 identified 11 potential sites in 5 candidate areas meeting the screening criteria: Eastern  
14 Tennessee; the Pacific Northwest; Eastern Idaho; Piketon, Ohio; and southeastern United  
15 States (Kairos 2021-TN7880). The key criteria used by the applicant to score the potential sites  
16 are (Kairos 2021-TN7880 | Sec 5.3.2):

- connectivity to future commercial reactor markets;
- access to construction resources;
- ability for timely acquisition;
- the existing local transportation and utility infrastructure;
- strong local community support;
- water availability;
- minimizing conflict with other major projects;
- minimizing reliance on the DOE as the landowner;
- avoiding sensitive environmental resources such as wetlands; and
- access to existing nuclear testing and research.

27 This process ultimately led the applicant to identify two reasonable alternative sites for a more  
28 detailed environmental analysis, consisting of the proposed Oak Ridge and Eagle Rock sites.

29 Although the applicant identified only one site in Oak Ridge (the proposed site in the East  
30 Tennessee Technology Park) for detailed evaluation, the applicant also considered two other  
31 sites near Oak Ridge Kairos 2022-TN7902). One site, identified in Table 5.3-1 of the ER as Site  
32 1.1, was the Clinch River Nuclear site approximately 2 mi south of the East Tennessee  
33 Technology Park for which the Tennessee Valley Authority received an early site permit from  
34 NRC for possible future construction and operation of small modular reactors (NRC 2019-  
35 TN6136). The other site, identified as Site 1.3, was another parcel on the Oak Ridge  
36 Reservation recently evaluated by DOE for another project. The proposed site was identified as  
37 Site 1.2 in ER Table 5.3-1. Of the three sites near Oak Ridge, only the proposed site provides  
38 an opportunity to limit land disturbance to previously industrialized lands lacking natural surface  
39 soils and vegetation. Therefore, the other two sites were not considered for detailed analysis.

1   **4.2.2   Affected Environment and Environmental Consequences for Eagle Rock Site**

2   *4.2.2.1   Affected Environment:*

3   The applicant characterized the affected environment at the Eagle Rock site in Section 5.4 of  
4   the ER (Kairos 2021-TN7880). Key aspects of the affected environment at the Eagle Rock site  
5   that substantially differ from those described in Section 3.0 for the proposed site in Oak Ridge  
6   are summarized below.

7   The Eagle Rock site constitutes approximately 4,200 acres (ac) of undeveloped land within  
8   Bonneville County, in eastern Idaho (Kairos 2021-TN7880). At the Eagle Rock site, the  
9   applicant has stated that the Hermes facilities would be built somewhere within a 592 ac portion  
10   of the site formerly evaluated by the NRC (NRC 2011-TN6812) for the proposed Eagle Rock  
11   Enrichment Facility (Kairos 2022-TN7902).

12   As depicted in Figure 5.4-5 of the ER, the 4,200 ac site presently consists of irrigated cropland,  
13   non-irrigated pasture, and natural sagebrush steppe vegetation (Kairos 2021-TN7880). Multiple  
14   wilderness study areas, national natural landmarks, national forests, national monuments, and  
15   national wildlife refuges are located within 50 mi of the site (Kairos 2021-TN7880). According to  
16   the NRC (NRC 2011-TN6812 | Sec 3.2.1), the Eagle Rock site is zoned as G-1 Grazing by  
17   Bonneville County, which allows for industrial development. The NRC notes that sagebrush  
18   steppe habitat has experienced more than a 98 percent decline since European settlement in  
19   North America, but the sagebrush steppe cover on the Eagle Rock site has been affected by  
20   grazing, resulting in soil disturbance and reduced cover by herbaceous species other than  
21   cheatgrass (*Bromus tectorum*) (NRC 2011-TN6812 | Sec 3.8.1). The site and surrounding  
22   counties are attainment areas under the Clean Air Act (Kairos 2021-TN7880 | Sec 5.4.1.2.1).  
23   Class I areas designated under the Clean Air Act near the site include the Craters of the Moon  
24   National Monument (47 mi to the west), Grand Teton National Park (65 mi to the east), and  
25   Yellowstone National Park (65 mi to the northeast). There are no rivers, lakes, streams,  
26   wetlands, or 100-year or 500-year floodplains on the site, although there are a few small  
27   drainage features that periodically carry water from irrigated agricultural areas (Kairos 2021-  
28   TN7880 | Sec 5.4.1.4.1).

29   A search by the applicant of the U.S. Fish and Wildlife Service Information for Planning and  
30   Consultation (IPaC) database on February 2, 2022, identified no threatened or endangered  
31   species or critical habitat listed under the Endangered Species Act (Endangered Species Act of  
32   1973-TN1010) for an action area consisting of that portion of the site where facilities would be  
33   built under this alternative (Kairos 2021-TN7880 | Sec 5.4.1.5.2). The action area used for the  
34   IPaC search consisted of the entirety of the 592 ac of land containing the area subject to  
35   disturbance by the Hermes facilities, plus any necessary access roads (Kairos 2022-TN7902).  
36   Because the land subject to disturbance by the Hermes facilities construction would constitute  
37   only a small part of the action area, the search conservatively addressed lands adjacent to as  
38   well as within the area where the facilities would be built. Significant archaeological resources  
39   are known to be present on the site, and some have already been identified to be eligible for  
40   listing in the National Register of Historic Places (Kairos 2021-TN7880 | Sec 5.4.1.6).

41   The Eagle Rock site is situated in a socioeconomic ROI defined by the applicant as three  
42   counties in Idaho (Bingham, Bonneville, and Jefferson Counties) located approximately 20 mi  
43   from the metropolitan area of Idaho Falls and part of the Idaho Falls-Rexburg-Blackfoot  
44   Combined Statistical Area (Kairos 2021-TN7880 | Sec 5.4.1.7.1). The applicant characterizes  
45   the demography, economy, community characteristics, public services, and transportation

1 facilities in Section 5.4.1.7 of the ER (Kairos 2021-TN7880). For an area surrounding the Eagle  
2 Rock site extending out by a 5 mi radius, the applicant identified no low-income populations  
3 subject to consideration as potential environmental justice communities of concern (Kairos  
4 2021-TN7880 | Sec 5.4.1.10).

5 **4.2.2.2 Environmental Consequences of Construction**

6 Building the proposed Hermes facilities at the Eagle Rock site would involve the temporary  
7 disturbance of approximately 95 ac of cropland, sagebrush, pasture, and upland grasslands;  
8 including some prime farmland, of which 30 ac would remain permanently in industrial use once  
9 the new facilities are built (Kairos 2021-TN7880 | Sec 5.4.1.1.1). These land use types are  
10 abundant in eastern Idaho, and the loss of 95 ac of prime farmland typical of the surrounding  
11 landscape would not affect the ability of the region to contribute to agricultural production.  
12 Based on information about the site's zoning, as reported by the NRC (NRC 2011-TN6812), the  
13 NRC staff believes that no zoning changes would be necessary. However, the visual changes  
14 to the landscape in the surrounding relatively undeveloped, flat, and treeless natural setting  
15 would be noticeable. Building a cluster of industrial buildings in a rural area with few previously  
16 established industrial or urban lands could noticeably alter scenic vistas extending long  
17 distances into the mostly flat and treeless landscape. The applicant notes that building the  
18 project could noticeably alter views from U.S. Route 20 as it passes through what is now a rural  
19 area with an undisturbed natural appearance (Kairos 2021-TN7880 | Sec 5.4.1.1.2).

20 Air emissions would be the same as those described for the proposed site in Oak Ridge in  
21 Section 3.2 of this draft EIS and low enough to be offset by mitigation, and below the threshold  
22 required for Class I area modeling (Kairos 2021-TN7880 | Sec 5.4.1.2.1). Noise generation  
23 would be at levels indicated for the same facilities on the proposed site in Oak Ridge, as  
24 described in Section 3.2 of this draft EIS, but the applicant expects the noise generated at the  
25 Eagle Rock site to be imperceptible to the nearest residence, which is approximately 4.8 mi  
26 away (Kairos 2021-TN7880 | Sec 5.4.1.2.2). The NRC staff expects that the noise is unlikely to  
27 disturb residents living at that distance. The applicant proposes to use best management  
28 practices to minimize adverse impacts on soils and other landscape features (Kairos 2021-  
29 TN7880 | Sec 5.4.1.3). Building the new facilities would not involve physical disturbance of any  
30 surface water features, wetlands, or floodplains (Kairos 2021-TN7880 | Sec 5.4.1.4.1). The  
31 applicant would have to develop groundwater supply wells, although usage rates would be  
32 substantially below the annual water right appropriation (Kairos 2021-TN7880 | Sec 5.4.1.4).  
33 Municipal water sources and municipal wastewater treatment facilities are not available.

34 Loss and disruption of sagebrush steppe habitat and other natural vegetation within the 95 ac  
35 subject to temporary disturbance could noticeably affect wildlife (Kairos 2021-TN7880 | Sec  
36 5.4.1.5.2). Unlike at the proposed site in Oak Ridge, ground disturbance at the Eagle Rock site  
37 would not be limited to soils previously graded and used for previous industrial development.  
38 Grading could disturb four archaeological sites located on the Eagle Rock site and possibly  
39 other uncharacterized archaeological sites (Kairos 2021-TN7880 | Sec 5.4.1.6). Unlike at the  
40 proposed site in Oak Ridge, soils on the Eagle Rock site have not been previously graded and  
41 disturbed for past industrial development. Site preparation therefore has a greater potential to  
42 disturb subsurface archaeological resources.

43 For certain resource areas, the environmental impacts during construction at the Eagle Rock  
44 site would resemble those at the proposed site in Oak Ridge, as presented in Section 3.0.  
45 Nonradiological and radiological human health (Section 3.8 of this draft EIS) and nonradiological  
46 waste management (Section 3.9 of this draft EIS) would have similar construction impacts. The

1 applicant would control nonradiological and radiological hazards to human health during  
2 construction in compliance with applicable regulations and standards (Kairos 2021-TN7880 |  
3 Sec 5.4.1.8). There are no low-income populations subject to consideration as potential  
4 environmental justice communities of concern within 5 mi of the Eagle Rock site (Kairos 2021-  
5 TN7880 | Sec 5.4.1.10), and hence there is no potential for environmental justice impacts.

6 *4.2.2.3 Environmental Consequences of Operation*

7 As would also be true for the proposed site in Oak Ridge, approximately 30 ac of land at the  
8 Eagle Rock site would remain permanently in industrial use over the four-year operational life of  
9 the proposed Hermes facilities (Kairos 2021-TN7880 | Sec 5.4.1.1.1). There would be no  
10 further visual changes to the site resulting from operation of the proposed facilities, and there  
11 would be no additional physical disturbance to natural habitats or subsurface cultural resources.  
12 Water usage for operations at the proposed site in Oak Ridge would generally be in quantities  
13 indicated in the Section 3.3 of this draft EIS, but the water supply would be obtained from onsite  
14 groundwater wells, remaining substantially below the annual water right appropriation (Kairos  
15 2021-TN7880 | Sec 5.4.1.4.2). According to the applicant, sanitary wastewater and  
16 nonradiological liquid waste generated over the life cycle of the Hermes facilities if built at the  
17 Eagle Rock site would be handled by portable systems or discharged to a yet to be constructed  
18 municipal wastewater treatment facility, and stormwater would be collected in a lined retention  
19 basin where it would ultimately evaporate (Kairos 2022-TN7902).

20 Air emissions due to operation of the Hermes facilities would be as described for the proposed  
21 site in Oak Ridge and be low enough to be offset by mitigation, and below the threshold for  
22 required Class I area modeling (Kairos 2021-TN7880 | Sec 5.4.1.2.1). Noise would be as  
23 described for the proposed site in Oak Ridge, but is expected to be imperceptible to the nearest  
24 residence, which is approximately 4.8 mi away (Kairos 2021-TN7880 | Sec 5.4.1.2.2).  
25 Operation of the proposed Hermes facilities would constitute only a very small portion of the  
26 total employment in the area surrounding the Eagle Rock site (Kairos 2021-TN7880 | Sec  
27 5.4.1.7.1). Occupational hazards and nonradiological and radiological sources, wastes, and  
28 effluents would be controlled in compliance with applicable regulations and standards (Kairos  
29 2021-TN7880 | Sec 5.4.1.8).

30 The environmental impacts during operations at the Eagle Rock site would be similar to those at  
31 the proposed site in Oak Ridge, as presented in Section 3.0 of this draft EIS. During operations,  
32 the nonradiological and radiological human health (Section 3.8 of this draft EIS), nonradiological  
33 waste management (Section 3.9 of this draft EIS), uranium fuel cycle and radiological wastes  
34 (Section 3.10 of this draft EIS), and accidents (Section 3.12 of this draft EIS) would have  
35 impacts at the Eagle Rock site similar to those at the proposed site in Oak Ridge. Regarding  
36 transportation of radioactive material, the NRC staff recognizes that the Eagle Rock site is in a  
37 different geographic region of the continental United States. However, the transportation  
38 analysis in Section 3.10 of this draft EIS for the proposed site in Oak Ridge would still bound the  
39 transportation impacts for the Eagle Rock site, if one applies the same assumptions (e.g., that  
40 fresh TRI-structural ISOtropic [TRISO] high-assay low-enriched uranium fuel is shipped from the  
41 farthest NRC-licensed fuel fabrication facility, the BWX Technologies, Inc. fuel fabrication facility  
42 in Lynchburg, VA, located at a distance of approximately 2,200 mi). The analysis would still be  
43 bounding for shipping shorter distances (e.g., shipping waste from the Eagle Rock site in Idaho  
44 to the EnergySolutions low-level radioactive waste [LLRW] disposal site in the adjacent state of  
45 Utah, or to the LLRW disposal site of Waste Control and Storage Services in Texas, a distance  
46 of approximately 1,200 mi). As discussed previously in this draft EIS, there would be no  
47 potential for environmental justice impacts based on the operation of the Hermes facilities.

- 1      4.2.2.4    *Environmental Consequences of Decommissioning*
- 2      The NRC staff expects that decommissioning of the Hermes facilities at the Eagle Rock site  
3      would proceed as described for decommissioning the same facilities at the proposed site in Oak  
4      Ridge. The staff expects that potential environmental impacts would generally resemble those  
5      described for the construction phase of the project. The staff recognizes that additional land  
6      disturbance outside of the 30 ac used during operations would be necessary during  
7      decommissioning. However, the staff believes that the additional disturbance could be readily  
8      accommodated by the remainder of the site, most likely within the 95 ac of land previously  
9      subjected to temporary disturbance during construction. For the reasons stated above for  
10     construction, there would be little potential for additional disturbance of ecological resources or  
11     subsurface cultural resources.
- 12     Potential impacts from transportation of radioactive material during decommissioning would also  
13     be bounded by the transportation impacts, as described in Section 3.10 of this draft EIS,  
14     because the LLRW disposal sites are closer to the Eagle Rock site than the proposed site in  
15     Oak Ridge. The Eagle Rock site is approximately 300 mi from the EnergySolutions LLRW  
16     disposal site and approximately 1,200 mi from the Waste Control and Storage Services LLRW  
17     disposal site, compared to 1,860 mi and 1,200 mi between the proposed site in Oak Ridge and  
18     each LLRW disposal site, respectively. This also holds true for the shipments of spent TRISO  
19     fuel, as these shipments would be going into the adjacent state of Nevada rather than being  
20     shipped across the United States from the proposed site in Oak Ridge.
- 21     The NRC staff expects that decommissioning impacts on most other environmental resources  
22     would be bounded by the analyses in the Decommissioning GEIS (NRC 2002-TN7254). The  
23     generic EIS concludes that impacts from decommissioning nuclear power facilities on aesthetics  
24     (including visual resources), water resources, air quality, noise, socioeconomics, human health  
25     (radiological and occupational), and transportation are typically SMALL (at most minimal) (NRC  
26     2002-TN7254). It concludes that decommissioning impacts on land use, ecology (including  
27     threatened and endangered species), and cultural resources are typically minimal within areas  
28     used during operations; but it does not reach a conclusion regarding impacts on those  
29     resources outside of the operational area. However, the NRC staff expects that most of the  
30     effects on land use, ecology, and cultural resources from decommissioning would generally be  
31     confined to areas previously affected by site preparation. It also does not reach a generic  
32     conclusion regarding environmental justice. But as noted for construction, there are no low-  
33     income populations subject to consideration as potential environmental justice communities of  
34     concern within 5 mi of the Eagle Rock site (Kairos 2021-TN7880 | Sec 5.4.1.10), and hence  
35     there are no potential environmental justice impacts.
- 36     4.2.2.5    *Cumulative Impacts*
- 37     The Eagle Rock site is located in a sparsely populated rural area where past and present  
38     environmental impacts are largely limited to agriculture and ranching. Table 5.4-20 of the ER  
39     identifies three reasonably foreseeable future projects that could cumulatively contribute to the  
40     environmental impacts of the Hermes project if it were sited at the Eagle Rock location (Kairos  
41     2021-TN7880). These include two transmission line projects and the proposed Carbon-Free  
42     Power Project (CFPP) at the Idaho National Laboratory in Idaho Falls. The NRC staff  
43     recognizes that the environmental impacts from these other major projects might be noticeable  
44     in the context of their immediate surroundings. However, the staff finds that the incremental  
45     effects of the Hermes project added to the effects of these other proposed projects would be  
46     minimal for each environmental resource, except for visual resources, ecological, and cultural

1 resources. The cumulative adverse visual effects of the Hermes project when combined with  
2 the CFPP and new transmission lines could be noticeable in the flat, largely treeless landscape  
3 with no substantial prior industrial or urban development. Similarly, the combined loss of  
4 sagebrush and other terrestrial habitats and combined disturbance of subsurface cultural  
5 resources from building the Hermes project at the Eagle Rock site and from the other nearby  
6 major projects could be noticeable.

7     4.2.2.6   *Conclusions*

8 Based on the analysis presented above, the NRC staff concludes that the potential direct,  
9 indirect, and cumulative impacts of construction, operation, and decommissioning the Hermes  
10 project at the Eagle Rock site would be SMALL for each environmental resource considered,  
11 with the exceptions that the visual, ecological, and cultural resource impacts from the  
12 construction would be MODERATE. Building even a small industrial project in a rural, treeless,  
13 flat landscape that has no previous industrial or urban development could noticeably alter the  
14 area's visual characteristics. Clearing sagebrush steppe vegetation could affect increasingly  
15 rare wildlife species dependent on this specialized habitat, such as the greater sage grouse  
16 (*Centrocercus urophasianus*). Grading previously undisturbed soils such as those at the Eagle  
17 Rock site could disturb archaeological resources. Otherwise, the small size and limited land  
18 disturbance of the Hermes project, abundance of land on the Eagle Rock site, presence of  
19 similar land cover in the surrounding rural area, low employment levels and water demands of  
20 the Hermes project, and absence of sensitive natural and hydrological features at the site  
21 suggest that implementing the project at the Eagle Rock site would have at most minimal  
22 adverse environmental impacts. Furthermore, although rural and remote, the Eagle Rock site is  
23 still proximate to the City of Idaho Falls and the Idaho National Laboratory, a DOE facility with  
24 technical staff and capabilities much like those in Oak Ridge.

25     4.3    Cost-Benefit of the Alternatives

26 As required by 10 CFR 51.71(d) (TN250), an EIS must include “a consideration of the  
27 economic, technical, and other benefits and costs of the proposed action and alternatives.” A  
28 principal objective of NEPA is to require each Federal agency to consider, in its decision-making  
29 process, the environmental impacts of each proposed major action and the available alternative  
30 actions. Specifically, Section 102 of NEPA (TN661) requires all Federal agencies to the fullest  
31 extent possible to:

32                 (B) identify and develop methods and procedures, in consultation with the  
33                 Council on Environmental Quality established by Title II of this Act, which will  
34                 ensure that presently unquantified environmental amenities and values may be  
35                 given appropriate consideration in decision making along with economic and  
36                 technical considerations (TN661).

37 However, neither NEPA nor the Council on Environmental Quality requires the costs and  
38 benefits of a proposed action or alternatives to be quantified in dollars or any other common  
39 metric. The purpose of this section is not to identify and quantify all the potential societal  
40 benefits and compare them to the potential costs of the proposed actions and alternatives.  
41 Instead, this section focuses only on those benefits and costs of such magnitude or importance  
42 that their inclusion in this analysis can inform the decision-making process. This section  
43 compiles and compares the pertinent analytical conclusions reached in earlier chapters of this  
44 draft EIS.

1   **4.3.1    Benefits**

2   In most cases, the most apparent benefit of the construction and operation of a nuclear power  
3   plant is that it generates power for thousands of residential, commercial, and industrial  
4   customers. However, the proposed Hermes project is planned as a demonstration project only  
5   and would not produce electricity. Consequently, the benefits from approval of the Hermes  
6   application include the following:

- 7   • Proof of concept: Once the test reactor is up and running, the Hermes project would be able  
8    to stimulate commercial interest in a new nuclear technology.
- 9   • Mass production of many of the components of the reactor would provide “off the shelf”  
10   standardized components that would help reduce the cost of construction and maintenance,  
11   making the full-sized KP-FHR cost-competitive with other generation methods, such as  
12   natural gas generation, in the U.S. market.
- 13   • Nuclear power is inherently carbon-free power, which would aid in achieving the United  
14    States’ climate change goals.
- 15   • Some limited economic stimuli would come from project-related incomes during the  
16    construction, operation, and decommissioning of the proposed project. However, the small  
17    scale of the construction crew (less than 500 workers) and operations crew (less than 100  
18    workers), and the fact that most of the skills needed for construction and operations are  
19    available locally, indicate that any increase in tax revenues derived from the proposed  
20    project would be minimal and relatively short termed (12 years from groundbreaking to  
21    cessation of operations).

22   **4.3.2    Costs**

23   The applicant did not provide cost (internal, external, fuel, waste disposal) information for the  
24   construction, operation, or decommissioning of the proposed project. The Hermes reactor is a  
25   scaled down KP-FHR, which is an advanced reactor technology that leverages TRISO fuel in  
26   pebble form combined with a low-pressure fluoride-lithium-beryllium (Flibe) salt coolant. The  
27   applicant won \$303 million in funding from the DOE’s Advanced Reactor Demonstration  
28   Program to build a prototype (NEI 2021-TN7970). The Hermes reactor would produce 35  
29   megawatts thermal (MWth) but would not produce any commercially valued product, such as  
30   electricity. Consequently, this cost analysis acts as a placeholder for any future submittal by  
31   Kairos that includes more detailed cost estimates.

32   Land use costs include approximately 185 ac of land, of which the applicant identifies about  
33   30 ac as “permanently disturbed for operations of the facility” (Kairos 2021-TN7880). No offsite  
34   lands would be disturbed or used, considering that the purpose of the project does not include  
35   transmission of electrical power, or the need for any pipelines or access roads. Because the  
36   proposed area of disturbance comprises previously disturbed soils and ruderal vegetation only,  
37   ecological costs and costs to cultural resources would be minimal.

38   As described in Section 3.2 of this draft EIS, emissions from diesel generators, equipment, and  
39   vehicles to the air would have a minimal impact on workers and residents. Emissions sources  
40   would be operated intermittently and would be managed in accordance with Federal, State, and  
41   local air quality limits. The NRC staff expects negligible impacts from sulfur dioxide, nitrogen  
42   oxide, carbon monoxide, carbon dioxide, and particulate matter, relative to other activities in the  
43   Oak Ridge area.

1    **4.3.3     Summary of Benefits and Costs**

2    On the basis of the assessments summarized in this draft EIS, the NRC staff concludes that  
3    building, operating, and decommissioning the proposed Hermes reactor (with the appropriate  
4    mitigation measures identified by the NRC staff), would have accrued benefits that most likely  
5    would outweigh its economic, environmental, and social costs. The staff draws this conclusion  
6    regardless of whether the project is sited at the proposed site in Oak Ridge or at the Eagle Rock  
7    site.

8    **4.4    Comparison of the Potential Environmental Impacts**

9    Table 4-1 tabulates the NRC staff's conclusions regarding the significance of potential  
10   environmental impacts for each environmental resource affected by each alternative evaluated  
11   in detail in this draft EIS. Each conclusion presented in the table is inclusive of direct, indirect,  
12   and cumulative impacts and reflects the full life cycle of the Hermes project, including  
13   construction, operation, and decommissioning. Potential environmental impacts from the no  
14   action alternative and the proposed action would be SMALL for each environmental resource  
15   identified for evaluation in this draft EIS. Potential environmental impacts from the Eagle Rock  
16   alternative would be SMALL for most environmental resources but would be MODERATE for  
17   land use and visual resources, ecological resources, and historic and cultural resources. These  
18   MODERATE conclusions reflect the fact that building the proposed Hermes facilities at the  
19   Eagle Rock site would require disturbance of soils supporting natural vegetation and potentially  
20   containing subsurface archaeological resources. Additionally, the visual appearance of the  
21   Hermes facilities could be noticeably intrusive in the rural setting of the Eagle Rock site. In  
22   contrast, building the Hermes facilities at the Oak Ridge site under the proposed action would  
23   disturb only soils previously disturbed by past industrial development of the now razed ORGDP  
24   and would take place within an existing industrial park (the Heritage Center in the East  
25   Tennessee Technology Park) that already contains industrial infrastructure and buildings.

26   Based on the analysis presented above, and the significance conclusions presented in  
27   Table 4-1, the NRC staff concludes that there are no environmentally preferable alternatives to  
28   the proposed action that meet the purpose and need of the proposed licensing action. Although  
29   the no action alternative might avoid some of the impacts described for the proposed action in  
30   Section 3.0, the no action alternative would not meet the purpose and need for the Hermes  
31   project. Furthermore, the analyses in Section 3.0 demonstrate that none of the impacts from  
32   the proposed action would be greater than SMALL, thus avoidance of the impacts would not be  
33   substantially preferable from an environmental perspective. Because the NRC staff did not  
34   identify any environmentally preferable alternatives that meet the purpose and need of the  
35   proposed action, the staff concludes that there are no obviously superior alternatives to the  
36   proposed action from an environmental perspective.

1      **Table 4-1    Comparison of Cumulative Environmental Impacts for Alternatives**  
2      **Evaluated in Detail**

Resource	No Action	Proposed Action (Oak Ridge Site)	Alternative Action (Eagle Rock Site)
Land use and visual resources	SMALL	SMALL	MODERATE
Air quality and noise	SMALL	SMALL	SMALL
Geological environmental and water resources	SMALL	SMALL	SMALL
Ecological resources	SMALL	SMALL	MODERATE
Historic and cultural resources	SMALL	SMALL	MODERATE
Socioeconomics	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL
Human health	SMALL	SMALL	SMALL
Nonradiological waste	SMALL	SMALL	SMALL
Fuel Cycle and radiological waste management	SMALL	SMALL	SMALL
Transportation	SMALL	SMALL	SMALL
Accidents	SMALL	SMALL	SMALL

3



## 1           5.0 CONCLUSIONS AND RECOMMENDATIONS

2     This environmental impact statement (EIS) describes the environmental review conducted by  
3     U.S. Nuclear Regulatory Commission (NRC) staff for a Kairos Power, LLC (Kairos) application  
4     for a construction permit (CP) under Title 10 of the *Code of Federal Regulations* Part 50  
5     (TN249) that would allow construction of the Hermes non-power test reactor facilities on a  
6     185 acre (ac) site within the Heritage Center Industrial Park (Heritage Center) in Oak Ridge,  
7     Tennessee. This EIS follows the requirements in 10 CFR Part 51 (TN250), which are the  
8     NRC's regulations that implement the National Environmental Policy Act of 1969 (NEPA,  
9     TN661). This section presents conclusions and recommendations based on the NRC staff's  
10    environmental review of the CP application. Section 5.1 summarizes the environmental impacts  
11    from construction, operation, and decommissioning of the Hermes project. Section 5.2  
12    compares the environmental impacts of the proposed action against reasonable alternatives  
13    identified by the NRC staff. Section 5.3 discusses the unavoidable impacts of the proposed  
14    action and identifies resource commitments. Section 5.4 presents the NRC staff's conclusions  
15    and recommendations.

### 16    **5.1   Environmental Impacts of the Proposed Action**

17    As indicated in Section 1.1 of this draft EIS, the proposed action is the NRC issuing a CP to  
18    Kairos authorizing construction of the proposed Hermes non-power test reactor facilities on a  
19    site in the Heritage Center in Oak Ridge, Tennessee. Section 1.2 presents the purpose and  
20    need of the Federal action, which is to demonstrate key technology of the Kairos Power Fluoride  
21    Salt-Cooled, High Temperature Reactor for possible future deployment. Section 3.0 of this draft  
22    EIS summarizes the direct, indirect, and cumulative impacts from construction, operation, and  
23    decommissioning the proposed Hermes facilities on the proposed site. As indicated in that  
24    section, the NRC staff concludes that the potential impacts from the proposed facilities would be  
25    SMALL for each potentially affected environmental resource. The staff based its conclusions on  
26    independent reviews of information provided in Kairos' application for the CP, including an  
27    Environmental Report (ER) and preliminary safety analysis report, as well as other relevant  
28    information sources. Table 5-1 summarizes the environmental impacts and the staff's  
29    conclusions for each resource considered.

30    **Table 5-1   Summary of Environmental Impacts from Construction, Operation, and**  
31    **Decommissioning of Proposed Hermes Facilities**

Resource Area	EIS Section	Summary of Impact	Impact Level
Land use and visual resources	3.1	Temporary disturbance of 138 ac of land previously occupied by industrial U.S. Department of Energy (DOE) buildings during construction and possibly during decommissioning. Permanent occupation of 30 ac of the same land. Limited land use options for the entire 185 ac Hermes site, which would be designated as an exclusion area throughout operation. The site is within an established industrial park. The setting is already industrial, and of low scenic quality. Facilities would have an industrial appearance compatible with an existing industrial park. The Hermes project is compatible with existing City of Oak Ridge zoning.	SMALL

Resource Area	EIS Section	Summary of Impact	Impact Level
Air quality and noise	3.2	Air emissions of criteria pollutants would be below 100 tons per year (TPY), and hazardous air pollutants would be below 10 TPY individually and 25 TPY combined. Emissions would comply with non-Title V permitting requirements. Standard control measures would be used to mitigate fugitive dust releases.	SMALL
Hydrogeology and water resources	3.3	There would be no disturbance of geological features of economic or natural value. Disturbances would be limited to previously disturbed soils. Best management practices (BMPs) would be employed for soil erosion and sediment control. Water demands would be met through municipal or commercial suppliers. There would be no use of groundwater and no direct use of surface water. No cooling towers, ponds, or reservoirs would be involved. Wastewater would be discharged for treatment to municipal wastewater treatment facilities. There would be limited, temporary dewatering of building excavations for construction. Dewatering water would be disposed in accordance with DOE requirements per the quit claim deed for the site. Stormwater would be managed using BMPs.	SMALL
Ecological resources	3.4	<p>Ground disturbance would be limited to areas of previously disturbed soils that lack vegetation or support only ruderal early successional vegetation. There would be no disturbances to forest cover or other natural vegetation growing on natural soils, wetlands, surface waters, shorelines, or riparian lands. No Clean Water Act Section 404 permit would be required. BMPs would be used to control stormwater runoff that might reach wetlands or aquatic habitats. Localized, minor increases in noise may affect wildlife, but area wildlife already experience industrial noise. Limited potential exists for wildlife to collide with new structures or be injured by vehicles.</p> <p>The Federally endangered gray bat (<i>Myotis grisescens</i>) and Indiana bat (<i>M. sodalis</i>) and Federally threatened northern long-eared bat (<i>M. septentrionalis</i>) are known to occur in the Oak Ridge area and may forage transiently on the site, but no potential roosting or breeding habitat would be disturbed, and foraging individuals can be expected to avoid areas of human activity. The U.S. Fish and Wildlife Service (FWS) will review the NRC staff's conclusions drawn in Table 3-4 of this draft EIS regarding resources protected under the Endangered Species Act (Endangered Species Act of 1973-TN1010). The final EIS will indicate whether the FWS concurs.</p>	SMALL

Resource Area	EIS Section	Summary of Impact	Impact Level
Historic and cultural resources	3.5	Historic properties would not be affected because none are located in the direct effects area of potential effects (APE). Ground disturbance would be limited to areas of extensive past soil disturbance with little potential for remaining archaeological resources. Kairos would also develop an Archaeological Monitoring and Discovery Plan establishing stop work and notification procedures to address unexpected discovery of human remains or archaeological material in compliance with deed requirements and Tennessee State law. The National Register of Historic Places-eligible Manhattan Project National Historical Park is located in the indirect effects APE but will not be adversely affected because the setting of the proposed Kairos project is visually compatible with the current industrial setting of the Manhattan Project National Historical Park.	SMALL
Socioeconomics and environmental justice (EJ)	3.6	Construction of the Hermes project would involve an average of 212 site workers per year over a two-year period with an estimated peak of 425 workers. Staffing during the four-year operational phase would average 38 workers per weekday (68 full-time positions). Decommissioning would involve an estimated peak employment level of 340 workers. These small numbers of workers would not substantially affect employment levels in the surrounding area, but the demand for some skilled labor might compete with other planned technology projects. The small size of the Hermes project and the distance of the site from the closest Census Blocks with populations meeting EJ criteria (over 8 miles [mi] away) indicate little potential for EJ effects.	SMALL
Human health	3.7	The site was formerly occupied by buildings that were part of the DOE Oak Ridge Gaseous Diffusion Plant used to enrich uranium, but DOE has already razed the buildings and remediated the site for unrestricted industrial reuse. DOE retains responsibility for remediation following any unanticipated discovery of legacy wastes. Based on information in the CP application, the NRC staff expects that radiological releases, doses to the public, and occupational doses would be less than the limits established for protection of human health and the environment in 10 CFR Part 20 (TN283). The applicant would implement normal safety practices contained in Occupational Safety and Health Administration regulations in 29 CFR Part 1910 (TN654) to protect occupational health. Emissions would comply with the Resource Conservation and Recovery Act (TN1281), Clean Air Act (TN1141), and other environmental regulations.	SMALL

Resource Area	EIS Section	Summary of Impact	Impact Level
Nonradiological waste management	3.8	Kairos would develop and implement a plan to manage wastes generated by the Hermes facilities. Management of solid waste, including construction and demolition wastes, would involve waste reduction efforts, recycling, and BMPs. Liquid wastes would be discharged for municipal treatment at a wastewater treatment plant or trucked offsite for proper disposal. Gaseous emissions would comply with Tennessee Department of Environment and Conservation regulations.	SMALL
Uranium fuel cycle and radiological waste management	3.9	A low quantity of uranium would be used during the four-year operational period. TRI-structural ISOtropic (TRISO) fuel processes (including enrichment and fuel fabrication) are bounded by Table S-3 in 10 CFR 51.51 (TN250), developed by NRC to protect human health and the environment. Environmental impacts from the storage of spent TRISO fuel from Hermes is bounded by the analysis in the Continued Storage Generic EIS. The estimated volume of low-level radioactive waste (LLRW) is less than or comparable to that from a light water reactor, and the staff determined that there is adequate capacity at LLRW disposal sites and that LLRW sites would accept the LLRW from Hermes. Onsite storage of spent TRISO fuel would have to meet the same regulatory requirements as currently licensed light water reactors.	SMALL
Transportation	3.10	Transportation of radioactive fuels and wastes to and from Hermes would be performed in compliance with U.S. Department of Transportation and NRC regulations and constitute only a small percentage of the total materials of these types shipped each year.	SMALL
Accidents	3.11	The NRC staff is conducting an independent review of the consequences of accidents and will document it in its Safety Evaluation Report. To receive a CP, the Hermes test reactor would have to meet the NRC requirements for postulated accidents, where potential doses at the exclusion area boundary and in the low population zone are below the dose reference values of 10 CFR Part 100 (TN282) for test reactor siting. Additionally, as another indication of the low-level of environmental impacts, the nearest resident dose from accidents is also below the radiation dose limits for individual members of the public in 10 CFR 20.1301(a) (TN283).	SMALL

## 1    **5.2 Comparison of Alternatives**

- 2    In Section 4.0 of this draft EIS, the NRC staff considered two alternatives to construction,  
 3    operation, and decommissioning of the proposed Hermes facilities at the proposed site in the  
 4    Heritage Center in Oak Ridge, Tennessee:

- 1     • the no action alternative; and  
2     • construction, operation, and decommissioning of the Hermes facilities at a site in Eagle  
3       Rock, Idaho (the Eagle Rock alternative).

4     The NRC staff independently reviewed information concerning other potential alternatives,  
5       including other alternative sites, and determined that there were no other reasonable  
6       alternatives warranting detailed evaluation. Because the Hermes project is designed to test a  
7       specific energy generation technology, alternatives involving other energy generation processes  
8       would not meet the project's purpose and need and hence were not analyzed in detail.  
9     Table 4-1 presents the staff's conclusions about the no action alternative, proposed action, and  
10      Eagle Rock alternative. The staff concluded that environmental impacts from the no action  
11      alternative and the proposed action would both be SMALL. The staff concluded that impacts on  
12      many environmental resources from the Eagle Rock alternative would likewise be SMALL, but  
13      impacts on land use and visual resources, ecological resources, and historic and cultural  
14      resources would be MODERATE. Building the Hermes facilities at the proposed site in Oak  
15      Ridge would introduce new industrial buildings to a previous industrial site within an existing  
16      industrial park of low aesthetic quality, whereas building the same facilities at the Eagle Rock  
17      site would introduce new industrial buildings to an open rural landscape free of previous urban  
18      encroachment. The new industrial buildings would noticeably alter the visual character of the  
19      existing open rural Idaho landscape. Furthermore, while land disturbance to build the Hermes  
20      facilities at the proposed site in Oak Ridge would be confined to areas of previously disturbed  
21      soils within the footprint of former industrial development, building the Hermes facilities at the  
22      Eagle Rock site would involve disturbance of natural vegetation, possibly including shrub-steppe  
23      vegetation, and natural soils known to contain subsurface archaeological resources. These  
24      disturbances would noticeably degrade the quality of existing ecological and cultural resources  
25      present on the site and possibly affect those qualities in the surrounding region.

26    The no action alternative would not meet the purpose and need identified for the Hermes  
27    project, as presented in Section 1.0 of this draft EIS. Of the alternatives considered that would  
28    meet the purpose and need for the Hermes project, the proposed action would result in fewer  
29    environmental impacts than the Eagle Rock alternative and is therefore the environmentally  
30    preferable alternative. The proposed site, which is the former location of two large industrial  
31    buildings that have been razed and the land remediated to allow industrial reuse, offers an  
32    opportunity to build new industrial buildings without disturbing sensitive natural or cultural  
33    resources or introducing industrial activity to areas lacking an industrial presence.

### 34    **5.3    Resource Commitments**

35    The following sections address issues related to resource commitments contributing to the cost-  
36    benefit analysis presented in Section 4.3 of this draft EIS.

#### 37    **5.3.1    Unavoidable Adverse Environmental Impacts**

38    NEPA Section 102(2)(C)(ii) (TN661) requires that an EIS include information about any adverse  
39    environmental effect that cannot be avoided if the proposal is implemented. Unavoidable  
40    adverse impacts are predicted adverse environmental impacts that cannot be avoided and that  
41    have no practical means of further mitigation. The applicant addresses unavoidable adverse  
42    environmental impacts in Section 6.1 of the ER (Kairos 2021-TN7880) and summarizes the  
43    unavoidable impacts and proposed mitigation in Tables 6.1-1 and 6.1-2 of the ER (Kairos 2021-  
44    TN7880).

1 As noted in Section 3.0 of this draft EIS, the NRC staff concluded that impacts on all resources  
 2 from construction, operation, and decommissioning of the Hermes facilities at the proposed site  
 3 would be SMALL. The environmental effects would not be detectable or would be so minor that  
 4 they would neither destabilize nor noticeably alter any important attribute of the resource.  
 5 However, a SMALL conclusion does not necessarily indicate that there would not be any  
 6 adverse effects that could be offset or minimized through mitigation. The NRC staff therefore  
 7 presents the unavoidable adverse impacts from construction, operation, and decommissioning  
 8 of the proposed Hermes facilities in Table 5-2, including mitigation and control measures  
 9 intended to lessen adverse effects. Unless noted otherwise, the mitigation measures presented  
 10 in Table 5-2 are taken from Section 6.1 of the applicant's ER, including Tables 6.1-1 and 6.1-2  
 11 (Kairos 2021-TN7880).

**Table 5-2 Unavoidable Adverse Environmental Impacts for Kairos Hermes Project**

Resource Area	Unavoidable Adverse Impact	Mitigation Measures
Land use and visual resources	Approximately 30 ac of unbuilt industrial land would be occupied from initiation of construction through decommissioning. An additional 108 ac may be temporarily occupied during construction and decommissioning. Limited land use options exist for the entire 185 ac Hermes site, which would be designated as an exclusion area throughout operation. New industrial buildings could be distantly visible from some nearby parks and residences.	Lands temporarily disturbed for parking or staging would be restored with native plants or landscaping when no longer needed (Kairos 2021-TN7880   Sec 6.1.1). The applicant would establish fencing, retain trees near the site perimeter, and install landscaping (Kairos 2021-TN7880   Sec 6.1.2 and Table 6.1.1). BMPs would control erosion and runoff (Kairos 2021-TN7880   Table 6.1.1). The applicant would have to comply with City of Oak Ridge zoning ordinances.
Air quality and noise	Emissions of criteria pollutants would be below 100 TPY and hazardous air pollutants below 10 TPY individually and 25 TPY combined. Fugitive dust releases would be possible during site preparation and decommissioning. Temporary, localized noise would be generated by some construction equipment.	BMPs would control dust (Kairos 2021-TN7880   Table 6.1.1). Construction equipment and vehicles would be properly maintained (Kairos 2021-TN7880   Sec 6.1.1). Post speed limits, traffic controls, and administrative measures such as staggered shift hours to reduce traffic noise would be implemented (Kairos 2021-TN7880   Sec 6.1.1 and Table 6.1.1).
Hydrogeology and water resources	Minor demands for water would be met through municipal or commercial suppliers. Limited, temporary dewatering would be necessary for the pit excavated to build the test reactor building. Stormwater would be managed using BMPs.	BMPs would be used to manage stormwater and control erosion and runoff (Kairos 2021-TN7880   Table 6.1.1). The applicant would develop and implement a stormwater pollution prevention plan (Kairos 2021-TN7880   Sec 6.1.2). Water from dewatering processes would be disposed of in accordance with DOE requirements established in the deed to the site (Kairos 2022-TN7902).

<b>Resource Area</b>	<b>Unavoidable Adverse Impact</b>	<b>Mitigation Measures</b>
Ecological resources	Localized, minor increases in noise that may affect wildlife in surrounding areas of existing industrial park. Limited potential exists for wildlife to collide with new structures or be injured by vehicles. Exposed soils create the potential for sedimentation of aquatic habitats.	No mitigation is proposed with respect to wildlife. BMPs would control runoff and sedimentation of aquatic habitats adjoining the site (Kairos 2021-TN7880   Table 6.1.1).
Historic and cultural resources	Potential, although unlikely, that there would be inadvertent discovery of cultural resources during excavation).	Development of an Archaeological Monitoring and Discovery Plan would establish stop work and notification procedures to address unexpected discoveries of human remains and archaeological material (Kairos 2021-TN7880   ER Sec 4.6.1 and Kairos 2022-TN7902).
Socioeconomics and EJ	Construction would involve an average of 212 site workers per year over a two-year period, with an estimated peak of 425 workers. Staffing during the four-year operational period would average 38 workers per weekday (68 full-time positions). Staffing during the four-year operational period would average 38 workers per weekday (68 full-time positions). Little potential exists for EJ effects.	No mitigation proposed.
Human health	Potential exists for physical and chemical hazards typical of any industrial facility. Workers and members of the public entering the Hermes facilities could be exposed to radiation.	BMPs would control human exposure to dust (Kairos 2021-TN7880   Table 6.1.1). Site-specific training of workers would minimize potential for injuries (Kairos 2021-TN7880   Table 6.1.1). The NRC staff expects that the applicant would implement normal safety practices contained in Occupational Safety and Health Administration regulations in 29 CFR Part 1910 (TN654).
Nonradiological waste management	Hermes would be a small quantity generator of hazardous waste.	The applicant would implement aggressive recycling and reuse programs (Kairos 2021-TN7880   Table 6.1.1).
Uranium fuel cycle and radiological waste management	A low quantity of uranium would be used during the four-year operational period. TRISO fuel processes (including enrichment and fuel fabrication) are bounded by Table S-3 in 10 CFR 51.51 (TN250), developed by NRC to protect human health and the environment. The estimated volume of LLRW is less than or comparable to that from a nuclear	Onsite storage of spent TRISO fuel must meet the same regulatory requirements as currently licensed light water reactors.

<b>Resource Area</b>	<b>Unavoidable Adverse Impact</b>	<b>Mitigation Measures</b>
Transportation	power plant, and the staff determined that there is adequate capacity at LLRW disposal sites and that LLWR sites would accept the LLRW from Hermes.	No mitigation measures proposed.
Accidents	The NRC staff is conducting an independent review of the consequences of accidents and will document it in its Safety Evaluation Report. Additionally, as another indication of the low level of environmental impacts, the nearest resident dose from accidents is also below the radiation dose limits for individual members of the public as mentioned in 10 CFR 20.1301(a) (TN283).	To receive a CP, the Hermes test reactor would have to meet the NRC requirements for postulated accidents, where potential doses at the exclusion area boundary and in low population zone are below the dose reference values of 10 CFR Part 100 (TN282) for test reactor siting.

1   **5.3.2   Relationship Between Local Short-Term Uses of the Environment and**  
 2   **Maintenance and Enhancement of Long-Term Productivity**

3   The construction, operation, and decommissioning of the proposed Hermes facilities under the  
 4   proposed action would result in short-term uses of environmental resources. “Short-term” is the  
 5   period of time during which construction, operation, and decommissioning activities would take  
 6   place. As noted in Section 2.0 of this draft EIS, Kairos plans to begin construction as early as  
 7   April 2023 (Kairos 2021-TN7880 | Sec 2.1) with an operational life of four years (Kairos 2022-  
 8   TN7881). While the applicant indicates that decommissioning would commence once the  
 9   facilities reach the end of their licensed life (Kairos 2021-TN7880 | Sec 2.1), the applicant does  
 10   not indicate how long decommissioning would take. Applicants for the licensing of new reactors  
 11   typically do not develop a plan for decommissioning when applying for CPs and/or operating  
 12   licenses.

13   As indicated in Section 3.1 of this draft EIS, construction, operation, and decommissioning of  
 14   the proposed Hermes facilities would require the short-term use of approximately 30 ac of  
 15   industrial land over the life of the project. This land would not be available for other uses during  
 16   that time but could be available for other uses after decommissioning. Construction would  
 17   require the temporary use of as much as 108 ac of additional previously used industrial land,  
 18   and decommissioning may require the temporary use of all or part of the additional land for a  
 19   second time. This additional land may be available for other uses beyond construction and  
 20   decommissioning. The applicant has designated the entire 185 ac Hermes site as the exclusion  
 21   area (Kairos 2021-TN7879 | Sec 2.1.1), within which it would have to limit land uses during  
 22   operation to ensure that no significant hazards to public health and safety are possible (10 CFR  
 23   Part 100-TN282). As indicated in Sections 3.1 and 3.5 of this draft EIS, the new facilities might  
 24   be distantly visible over the life of the Hermes project from nearby parks and residential areas,

1 but they would be part of a cluster of existing and new industrial facilities that are also part of the  
2 East Tennessee Technology Park Heritage Center. Once the new facilities are razed as part of  
3 decommissioning, they would no longer be visible.

4 As indicated in Sections 3.2 and 3.7 of this draft EIS, air emissions from construction, operation,  
5 and decommissioning of the Hermes facilities would introduce small amounts of criteria  
6 pollutants, greenhouse gas emissions, hazardous air pollutants, and radiological emissions at  
7 the facility site. However, such emissions are not expected to affect air quality to the extent that  
8 they would impair public health and the long-term productivity of the environment. Emission  
9 levels will be below all regulatory thresholds for major sources. Noise emitted by construction,  
10 operation, and decommissioning activities would increase the ambient noise levels onsite and in  
11 adjacent offsite areas. However, increases in noise levels are not expected to be noticeable,  
12 other than for temporary periods during construction and decommissioning. Any noticeable  
13 increases in noise levels would be brief and temporary.

14 As indicated in Section 3.3 of this draft EIS, the Hermes project would require the use of only  
15 small quantities of water, supplied by municipal or commercial sources, which would not even  
16 place short-term substantial demands on surface water or groundwater resources. As  
17 explained in Section 3.4 of this draft EIS, unlike projects that require the conversion of natural  
18 habitat to urban land uses, thereby displacing wildlife and reducing the availability of wildlife  
19 habitat over the life of the project, the Hermes project would be limited to empty but previously  
20 developed land that still retains foundation rubble and other industrial features from previous  
21 Department of Energy (DOE) uses. Any short-term ecological effects would be minor and  
22 cease prior to completion of decommissioning.

23 Increased employment, expenditures, and tax revenues generated during construction,  
24 operation, and decommissioning activities directly benefit local, regional, and State economies  
25 over the short term. As noted in Section 3.6 of this draft EIS, worker vehicles and the delivery  
26 and shipment of materials would increase the volume of traffic on local roads. There may also  
27 be small increases in demand for housing and services in Oak Ridge and the surrounding  
28 areas. But these demands and traffic increases would be short-term and expected during peak  
29 construction and decommissioning activities and during work shifts. Therefore, these demands  
30 and traffic increases would not affect long-term productivity.

31 As indicated in Sections 3.7 and 3.8 of this draft EIS, management and disposal of low-level  
32 radioactive waste, hazardous waste, and nonhazardous waste would require a small short-term  
33 increase in energy usage and consume space at treatment, storage, or disposal facilities.  
34 Regardless of the location of those facilities, the use of land to meet waste disposal needs  
35 would reduce the long-term productivity of the land. The contribution of Hermes to these  
36 reductions would be minimal.

37 While the uses of, and impacts on, environmental resources would be minimal over the short  
38 term, the long-term benefits from implementation of the Hermes project could be substantial.  
39 Operation of the Hermes facilities could help demonstrate the commercial viability of the Kairos  
40 Power Fluoride Salt-Cooled High Temperature (KP-FHR) technology and may generate data  
41 helpful in future commercial deployment of the technology. Successful future deployment of the  
42 technology could help the United States develop another economically viable source of energy  
43 and help the nation meet its climate change objectives. Use of the technology may help the  
44 United States meet its climate change goals with less reliance on more land-intensive energy  
45 generation processes, such as large complexes of solar photovoltaic cells or wind turbines, that

1 require larger commitments of land and have a greater potential for aesthetic impact on  
2 landscapes and seascapes and physical injury to terrestrial or aquatic wildlife.

3 **5.3.3 Irreversible and Irretrievable Commitment of Resources**

4 This section describes the irreversible and irretrievable commitment of resources that have  
5 been noted in this draft EIS. Resource losses or degradation are irreversible when primary or  
6 secondary impacts limit future options for a resource. An irretrievable commitment refers to the  
7 use or consumption of resources that are neither renewable nor recoverable for future use.  
8 Irreversible and irretrievable commitments of resources for construction, operation, and  
9 decommissioning of a non-power test reactor facility such as Hermes include the commitment of  
10 water, energy, raw materials, and other natural and human-made resources. In general, the  
11 commitment of capital, energy, labor, and material resources for a project such as Hermes are  
12 also irreversible.

13 Building, operating, and decommissioning the proposed Hermes facility at the proposed site in  
14 Oak Ridge, Tennessee (proposed action), or at the alternative Eagle Rock site near Idaho Falls,  
15 Idaho (alternative action considered in detail in this draft EIS), would entail the irreversible and  
16 irretrievable commitment of energy, water, chemicals, fossil fuels, and other natural and human-  
17 made resources. Building the Hermes facilities at either site would consume concrete,  
18 structural steel, steel sheet pilings, precast piles, precast panels, asphalt, stone, roofing/siding,  
19 and temporary tent structures, as quantified by the applicant in Table 2.1-1 of the ER (Kairos  
20 2021-TN7880). These materials would be irretrievable unless Kairos recycles them during  
21 decommissioning (e.g., finds another facility to use such materials).

22 During operation, the reactor core would be fueled using 4 centimeter (cm) diameter graphite  
23 pebbles with embedded coated TRISO particle fuel, with each particle comprising a uranium  
24 fuel kernel with a maximum uranium enrichment of 19.55 wt% (Kairos 2021-TN7880 | Sec 2.3).  
25 The availability of uranium ore and existing uranium stockpiles, including downblending of highly  
26 enriched uranium, in the United States and from foreign sources (e.g., Australia and Canada)  
27 that could be processed into fuel is sufficient to support the operation of the Hermes test reactor  
28 (WNA 2022-TN7971). Thus, the irreversible and irretrievable commitment of the quantity of  
29 uranium (0.93 metric tons [MT] of uranium) to be used in the Hermes test reactor would have a  
30 negligible impact on United States uranium supplies. Over the anticipated four-year operational  
31 period, the applicant estimates that 155,200 used TRISO pebbles would be produced as waste  
32 (Kairos 2022-TN7881 | Sec 2.6.1.2.4). These used TRISO fuel pebbles would be an  
33 irretrievable use of fuel and would not be available to fuel other advanced reactors.

34 As described in Section 3.3 of this draft EIS, the water demands of the Hermes facilities at  
35 either site would be minimal and readily met by municipal and commercial sources. These  
36 water resources are readily available at both sites, and the amounts required are not expected  
37 to deplete available supplies or exceed available system capacities. As described in  
38 Section 3.4 of this draft EIS, a small number of birds and other wildlife could be killed or injured  
39 by collision with the Hermes structures or collision with vehicles used on either site or by  
40 workers traveling to either site. These losses of wildlife would be to minor in terms of  
41 irreversibly affecting wildlife populations in the surrounding area, and any affected populations  
42 can be expected to subsequently recover. As noted in Section 4.2.2 of this draft EIS, building  
43 the Hermes facilities at the Eagle Rock site would disturb approximately 95 ac of cropland,  
44 sagebrush, pasture, and upland grasslands, including some prime farmland. Although the  
45 affected land could be restored to rural uses after the Hermes project, some of the desirable  
46 ecological properties of the sagebrush and agricultural quality of the prime farmland soils may

1 not be fully restorable, and hence would be irreversible. Irreversible losses of natural habitat or  
2 agricultural land would not be a possibility at the proposed Oak Ridge site, because, as  
3 described in Section 3.4 of this draft EIS, soils within all of the land subject to disturbance for the  
4 Hermes project have been heavily disturbed by past industrial development and currently  
5 support only ruderal vegetation. Any disturbances to subsurface cultural resources at the Eagle  
6 Rock site could be irreversible.

7 As noted in Section 3.7 of this draft EIS, nonradiological irreversible commitments to  
8 occupational human health resources may occur. Such impacts would be similar to potential  
9 hazards that occur at any industrial construction site. Energy expended would be in the form of  
10 fuel for equipment, vehicles, and facility operation and electricity for equipment and facility  
11 operation. Electricity and fuel would be acquired from offsite commercial sources.

#### 12 **5.3.4 Unresolved Conflicts**

13 NEPA Section 102(2)(E) (TN661) requires that the NRC staff study, develop, and describe  
14 appropriate alternatives to recommended courses of action in any proposal that involves  
15 unresolved conflicts concerning alternative uses of available resources. In reviewing the  
16 potential impacts associated with the proposed action, the NRC staff did not identify any  
17 unresolved conflicts concerning alternative uses of available resources.

#### 18 **5.4 Recommendation**

19 After weighing the environmental, economic, technical, and other benefits against environmental  
20 and other costs, and considering reasonable alternatives, the NRC staff recommends, unless  
21 safety issues mandate otherwise, that the NRC issue the CP to Kairos for the Hermes facility.  
22 The NRC staff based its recommendation on the following:

- 23 • the NRC staff's review of Kairos' ER (Kairos 2021-TN7880) and associated responses to  
24 requests for clarifying information (RCI);
- 25 • the NRC staff's review of comments received as part of the scoping process;
- 26 • the NRC staff's communications with, and scoping comments received from, Federal, State,  
27 and local agencies, as well as Tribal officials; and
- 28 • the NRC staff's independent environmental review.

29 The NRC's staff's recommendation in this draft EIS is tentative. Before identifying a final  
30 recommendation in the final EIS, the NRC staff will also consider comments received on the  
31 draft EIS from Federal, State, local, and Tribal officials, and members of the public.



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## APPENDIX A

### CONTRIBUTORS TO THE ENVIRONMENTAL IMPACT STATEMENT

Members of the U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Material Safety and Safeguards (NMSS); Division of Rulemaking, Environmental, and Financial Support (REFS); and Environmental New Reactor Branch (ENRB) prepared this draft environmental impact statement (EIS). Staff from other NRC branches and from Pacific Northwest National Laboratory (PNNL) provided supplemental technical support and technical editing. Table A-1 below identifies each contributor's name and affiliation, summary of education and experience, and indication of function or expertise contributed to the document.

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Palmrose, Donald NRC	Ph.D. Nuclear Engineering M.S. Nuclear Engineering B.S. Nuclear Engineering Duke NEPA Certificate 36 years of relevant experience	Radiological Health Postulated Accidents Uranium Fuel Cycle Radiological Waste Transportation of Rad. Material
Parker, Mike PNNL	B.S. English Literature & Creative Writing 25 years of relevant experience	Technical Editing Document Architecture
Saulsbury, Bo PNNL	M.S. Planning B.A. History 35 years of relevant experience	PNNL Team Lead Comment Database
Sen, Kacoli PNNL	Ph.D. Cancer Biology M.S. Zoology (Ecology) B.S. Zoology Diploma in Environmental Law 6 years of relevant experience	Technical Editing Formatting
Willingham, Laura NRC	B.S. Environmental Sciences 17 years of relevant experience	Air Quality Greenhouse Gases Climate Change

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## APPENDIX B

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### AGENCIES, ORGANIZATIONS, AND INDIVIDUALS CONTACTED

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4 The U.S. Nuclear Regulatory Commission (NRC) is providing copies of the Kairos Hermes Test  
 5 Reactor Construction Permit Draft Environmental Impact Statement to the organizations and  
 6 individuals listed in Table B-1 below. The NRC will also send this draft to the approximately 39  
 7 citizens that provided scoping comments and contact information during the scoping period held  
 8 from February 18 to April 19, 2022. The NRC will provide copies to other interested  
 9 organizations and individuals upon request.

10 **Table B-1 List of Agencies, Organizations, and Persons to Whom Copies of this**  
 11 **Environmental Impact Statement Are Sent**

Name	Affiliation	Contact Information
<b>Federal and State Agencies</b>		
Reid Nelson	Advisory Council on Historic Preservation	401 F Street NW, Suite 308 Washington DC 20001-2637
E. Patrick McIntyre	State Historic Preservation Office	2941 Lebanon Pike Nashville, TN 37214 section.106@tn.gov
Larry Long	U.S. Environmental Protection Agency, Region 4	NEPA Program Office USEPA Region 4 61 Forsyth Street SW Atlanta, GA 30303 long.larry@epa.gov
Mary Jennings	US Fish and Wildlife Service	U.S. Fish and Wildlife Service Tennessee Ecological Services Field Office 446 Neal Street Cookeville, TN 38501-4027 mary_e_jennings@fws.gov
Kris Kirby	National Park Service: Manhattan Project National Historical Park	12795 West Alameda Parkway P.O. Box 25287 Denver, Colorado 80225-0287 nps_environ_rev@nps.gov
Niki Nicholas	National Park Service: Manhattan Project National Historical Park	niki_nicholas@nps.gov
Dave Adler	Department of Energy	david.sdler@orem.doe.gov
<b>Tribes</b>		
John Raymond Johnson, Governor	Absentee Shawnee Tribe	2025 S. Gordon Cooper Drive Shawnee, OK 74801
Nita Battise, Tribal Council Chairwoman	Alabama-Coushatta Tribe of Texas	571 State Park Road 56 Livingston, TX 77351
Wilson Yargee, Chief	Alabama-Quassarte Tribal Town	P.O. Box 187 Wetumka, OK 74883
Chuck Hoskin, Jr., Principal Chief	Cherokee Nation	P.O. Box 948 Tahlequah, OK 74465

Name	Affiliation	Contact Information
Richard Sneed, Principal Chief	Eastern Band of Cherokee Indians	Qualla Boundary P.O. Box 1927 Cherokee, NC 28719
Glenna J. Wallace, Chief	Eastern Shawnee Tribe of Oklahoma	12705 South 705 Road Wyandotte, OK 74370
Brian Givens, Town King	Kialegee Tribal Town	P.O. Box 332 Wetumka, OK 74883
David Hill, Principal Chief	Muscogee (Creek) Nation	P.O. Box 580 Omulgee, OK 74447
Greg P. Chilcoat, Principal Chief	Seminole Nation of Oklahoma	P.O. Box 1498 Wewoka, OK 74884
Marcellus W. Osceola, Jr., Chairman	Seminole Tribe of Florida	6300 Stirling Road Hollywood, FL 33024
Benjamin Barnes, Chief	Shawnee Tribe	P.O. Box 189 Miami, OK 74354
Ryan Morrow, Town King	Thlophlocco Tribal Town	P.O. Box 188 Okemah, OK 74859
Joe Bunch, Chief	United Keetoowah Band of Cherokee Indians of Oklahoma	P.O. Box 746 Tahlequah, OK 74465
David Sickey, Chairman	Coushatta Tribe of Louisiana	P.O. Box 818 Elton, LA 70532
B. Cheryl Smith, Principal Chief	Jena Band of Choctaw Indians	P.O. Box 14 Jena, LA 71432
Other Organizations and Individuals		
Mark Watson	City of Oak Ridge	<a href="mailto:mwatson@oakridgetn.gov">mwatson@oakridgetn.gov</a>
Amy Fitzgerald	City of Oak Ridge	<a href="mailto:afitzgerald@oakridgetn.gov">afitzgerald@oakridgetn.gov</a>
Ron Woody	Roane County	<a href="mailto:ron.woody@roanecountytn.org">ron.woody@roanecountytn.org</a>
Peter Hastings	Kairos Power, LLC	<a href="mailto:hastings@kairospower.com">hastings@kairospower.com</a>
Heather Hoff	Mothers for Nuclear	<a href="mailto:heather@mothersfornuclear.org">heather@mothersfornuclear.org</a>
Martin O'Neill	Nuclear Energy Institute	<a href="mailto:mjo@nei.org">mjo@nei.org</a>
Kati Austgen	Nuclear Energy Institute	<a href="mailto:kra@nei.org">kra@nei.org</a>
Alan Ahn	Third Way	<a href="mailto:aahn@thirdway.org">aahn@thirdway.org</a>
D.A. Smith	Nuclear Matters	<a href="mailto:dasmith@apocworldwide.com">dasmith@apocworldwide.com</a>
Danielle Emche	Nuclear Innovation Alliance	<a href="mailto:demche@nuclearinnovationalliance.org">demche@nuclearinnovationalliance.org</a>
Natalie Houghtalen	ClearPath	<a href="mailto:houghtalen@clearpath.org">houghtalen@clearpath.org</a>
Brad Parish	Advanced Technologies & Laboratories	<a href="mailto:bparish@atlintl.com">bparish@atlintl.com</a>
Rani Franovich	The Breakthrough Institute	<a href="mailto:rani@thebreakthrough.org">rani@thebreakthrough.org</a>

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## APPENDIX C

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### CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

4 This appendix contains a chronological list of correspondence between the U.S. Nuclear  
5 Regulatory Commission (NRC) and external parties as part of its environmental review for the  
6 Kairos Hermes Test Reactor. These documents are available electronically on the NRC's  
7 website at <https://www.nrc.gov/reading-rm.html>. From this website, members of the public can  
8 gain access to the NRC's Agencywide Document Access and Management Systems (ADAMS),  
9 which provides text and image files of the NRC's public documents in the Publicly Available  
10 Records component of ADAMS. The ADAMS accession numbers for each document are  
11 included below. Some of the ADAMS accession numbers below lead to a folder containing  
12 several documents. If you need assistance in accessing or searching in ADAMS, contact the  
13 Public Document Room staff at 1-800-397-4209.

- 14 September 29, 2021 Letter to NRC from Peter Hastings, Kairos Power, Submitting the  
15 Preliminary Safety Evaluation Report for the Kairos Power Fluoride Salt-  
16 Cooled, High Temperature Non-Power Reactor (Hermes) (Rev 0).  
17 (Package Accession No. ML21272A375)
- 18 October 28, 2021 Letter to NRC from Peter Hastings, Kairos Power, Submitting the  
19 Environmental Report for the Kairos Power Fluoride Salt-Cooled, High  
20 Temperature Non-Power Reactor (Hermes) (Rev 0). (Package Accession  
21 No. ML21306A131)
- 22 October 29, 2021 *Federal Register* Notice - NRC Receipt of Kairos Hermes Test Reactor  
23 Construction Permit Application (86 FR 60077)
- 24 November 29, 2021 Letter from NRC to Peter Hastings, Kairos Power, Acceptance for  
25 Docketing Application for Hermes Non-Power Test Reactor Construction  
26 Permit Application. (Accession No. ML21319A354)
- 27 December 1, 2021 *Federal Register* Notice - Construction Permit Application; Acceptance for  
28 Docketing. (86 FR 68290)
- 29 December 15, 2021 Letter from NRC to Peter Hastings, Kairos Power, Regarding the Kairos  
30 Hermes Construction Permit Application Review Schedule and Resource  
31 Estimate. (Accession No. ML21343A214)
- 32 February 2, 2022 Kairos Hermes Construction Permit Environmental Report Audit Plan.  
33 (Package Accession No. ML22056A064)
- 34 February 8, 2022 Letter from NRC to Peter Hastings, Kairos Power, Application for  
35 Construction Permit Hermes Test Reactor, Notice of Hearing, Opportunity  
36 to Petition for Leave to Intervene, and Associated Federal Register  
37 Notice. (Package Accession No. ML21364A012)
- 38 February 9, 2022 *Federal Register* Notice - Notice of Hearing and Opportunity to Petition for  
39 Leave to Intervene; Order Imposing Procedures. (87 FR 7503)

- 1      February 10, 2022      Letter to NRC from Peter Hastings, Kairos Power, Transmittal of Changes  
2                                  to the Construction Permit Application. (Package Accession No.  
3                                  ML22042A095)
- 4      February 18, 2022      Letter from NRC to Peter Hastings, Kairos Power, Notice of Intent to  
5                                  Prepare an Environmental Impact Statement and Conduct Scoping  
6                                  Related to an Early Site Permit for the Clinch River Nuclear Site.  
7                                  (Package Accession No. ML22053A010)
- 8      February 18, 2022      *Federal Register* Notice of Intent to Conduct Scoping Process and  
9                                  Prepare an Environmental Impact Statement. (87 FR 9394)
- 10     February 18, 2022      Letter to NRC from Peter Hastings, Kairos Power, Transmittal of  
11                                  Construction Permit Application Changes. (Package Accession No.  
12                                  ML22049B555)
- 13     March 1, 2022      Letter to NRC from Peter Hastings, Kairos Power, Transmittal of Changes  
14                                  to Maximum Hypothetical Accident Dose Results in Hermes Construction  
15                                  Permit Application. (Accession No. ML22060A272)
- 16     March 4, 2022      Letter from NRC to E. Patrick McIntyre, Jr., Tennessee Historical  
17                                  Commission, Request to Initiate Section 106 Consultation and Scoping  
18                                  Process for the Kairos Hermes Non-Power Test Reactor Construction  
19                                  Permit Review in Roane County, Tennessee (Accession No.  
20                                  ML22031A288)
- 21     March 4, 2022      Letter from NRC to Reid Nelson, Advisory Council on Historic  
22                                  Preservation, Request to Initiate Section 106 Consultation and Scoping  
23                                  Process for the Kairos Hermes Non-Power Test Reactor Construction  
24                                  Permit Review in Roane County, Tennessee (Accession No.  
25                                  ML22031A286)
- 26     March 4, 2022      Letter from NRC to Niki Nicholas, Manhattan Project National Historic  
27                                  Park, Request to Initiate Section 106 Consultation and Scoping Process  
28                                  for the Kairos Hermes Non-Power Test Reactor Construction Permit  
29                                  Review in Roane County, Tennessee (Accession No. ML22031A287)
- 30     March 4, 2022      Letter from NRC to Mary Jennings, U.S. Fish and Wildlife Service,  
31                                  Request For Participation In The Environmental Scoping Process And A  
32                                  List Of Protected Species Within The Area Under Evaluation For The  
33                                  Proposed Kairos Hermes Test Reactor Construction Permit Application  
34                                  Review. (Accession No. ML22033A241)
- 35     March 4, 2022      Letter from NRC to Larry Long, Environmental Protection Agency,  
36                                  Request For Participation In The Environmental Scoping Process For the  
37                                  Proposed Kairos Hermes Test Reactor Construction Permit Application  
38                                  Review. (Accession No. ML22033A246)

- 1      March 4, 2022      Letter from NRC to John Raymond Johnson, Absentee Shawnee Tribe,  
2      Request to Initiate Section 106 Consultation and Scoping Process for the  
3      Kairos Hermes Non-Power Test Reactor Construction Permit Review in  
4      Roane County, Tennessee. (Accession No. ML22031A289)
- 5      March 4, 2022      Letter from NRC to Ms. Nita Battise, Alabama-Coushatta Tribe of Texas,  
6      Request to Initiate Section 106 Consultation and Scoping Process for the  
7      Kairos Hermes Non-Power Test Reactor Construction Permit Review in  
8      Roane County, Tennessee. (Accession No. ML22031A289)
- 9      March 4, 2022      Letter from NRC to Mr. Wilson Yargee, Chief, Alabama-Quassarte Tribal  
10     Town, Request to Initiate Section 106 Consultation and Scoping Process  
11     for the Kairos Hermes Non-Power Test Reactor Construction Permit  
12     Review in Roane County, Tennessee. (Accession No. ML22031A289)
- 13     March 4, 2022      Letter from NRC to Mr. Chuck Hoskin, Jr., Principal Chief, Cherokee  
14     Nations, Request to Initiate Section 106 Consultation and Scoping  
15     Process for the Kairos Hermes Non-Power Test Reactor Construction  
16     Permit Review in Roane County, Tennessee. (Accession No.  
17     ML22031A289)
- 18     March 4, 2022      Letter from NRC to Mr. Bill Anoatubby, Chickasaw Nation, Request to  
19     Initiate Section 106 Consultation and Scoping Process for the Kairos  
20     Hermes Non-Power Test Reactor Construction Permit Review in Roane  
21     County, Tennessee. (Accession No. ML22031A289)
- 22     March 4, 2022      Letter from NRC to Mr. Richard Sneed, Principal Chief, Eastern Band of  
23     Cherokee Indians, Request to Initiate Section 106 Consultation and  
24     Scoping Process for the Kairos Hermes Non-Power Test Reactor  
25     Construction Permit Review in Roane County, Tennessee. (Accession  
26     No. ML22031A289)
- 27     March 4, 2022      Letter from NRC to Ms. Glenna J. Wallace, Chief, Eastern Shawnee Tribe  
28     of Oklahoma, Request to Initiate Section 106 Consultation and Scoping  
29     Process for the Kairos Hermes Non-Power Test Reactor Construction  
30     Permit Review in Roane County, Tennessee. (Accession No.  
31     ML22031A289)
- 32     March 4, 2022      Letter from NRC to Mr. Brian Givens, Town King, Kialegee Tribal Town,  
33     Request to Initiate Section 106 Consultation and Scoping Process for the  
34     Kairos Hermes Non-Power Test Reactor Construction Permit Review in  
35     Roane County, Tennessee. (Accession No. ML22031A289)
- 36     March 4, 2022      Letter from NRC to Mr. David Hill, Principal Chief, Muscogee (Creek)  
37     Nation, Request to Initiate Section 106 Consultation and Scoping Process  
38     for the Kairos Hermes Non-Power Test Reactor Construction Permit  
39     Review in Roane County, Tennessee. (Accession No. ML22031A289)

- 1    March 4, 2022    Letter from NRC to Ms. Stephanie A. Bryan, Tribal Chair, Poarch Band of  
2                      Creek Indians, Request to Initiate Section 106 Consultation and Scoping  
3                      Process for the Kairos Hermes Non-Power Test Reactor Construction  
4                      Permit Review in Roane County, Tennessee. (Accession No.  
5                      ML22031A289)
- 6    March 4, 2022    Letter from NRC to Mr. Greg P. Chilcoat, Principal Chief, Seminole Nation  
7                      of Oklahoma, Request to Initiate Section 106 Consultation and Scoping  
8                      Process for the Kairos Hermes Non-Power Test Reactor Construction  
9                      Permit Review in Roane County, Tennessee. (Accession No.  
10                     ML22031A289)
- 11   March 4, 2022    Letter from NRC to Mr. Marcellus W. Osceola, Jr., Seminole Tribe of  
12                      Florida, Request to Initiate Section 106 Consultation and Scoping  
13                      Process for the Kairos Hermes Non-Power Test Reactor Construction  
14                      Permit Review in Roane County, Tennessee. (Accession No.  
15                     ML22031A289)
- 16   March 4, 2022    Letter from NRC to Mr. Benjamin Barnes, Chief, Shawnee Tribe, Request  
17                      to Initiate Section 106 Consultation and Scoping Process for the Kairos  
18                      Hermes Non-Power Test Reactor Construction Permit Review in Roane  
19                      County, Tennessee. (Accession No. ML22031A289)
- 20   March 4, 2022    Letter from NRC to Mr. Ryan Morrow, Town King, Thlopthlocco Tribal  
21                      Town, Request to Initiate Section 106 Consultation and Scoping Process  
22                      for the Kairos Hermes Non-Power Test Reactor Construction Permit  
23                      Review in Roane County, Tennessee. (Accession No. ML22031A289)
- 24   March 4, 2022    Letter from NRC to Mr. Joe Bunch, Chief, United Keetoowah Band of  
25                      Cherokee Indians, Request to Initiate Section 106 Consultation and  
26                      Scoping Process for the Kairos Hermes Non-Power Test Reactor  
27                      Construction Permit Review in Roane County, Tennessee. (Accession  
28                     No. ML22031A289)
- 29   March 4, 2022    Letter from NRC to Mr. David Sickey, Chairman, Coushatta Tribe of  
30                      Louisiana, Request to Initiate Section 106 Consultation and Scoping  
31                      Process for the Kairos Hermes Non-Power Test Reactor Construction  
32                      Permit Review in Roane County, Tennessee. (Accession No.  
33                     ML22031A289)
- 34   March 4, 2022    Letter from NRC to Ms. B. Cheryl Smith, Principal Chief, Jena Band of the  
35                      Choctaw Indians, Request to Initiate Section 106 Consultation and  
36                      Scoping Process for the Kairos Hermes Non-Power Test Reactor  
37                      Construction Permit Review in Roane County, Tennessee. (Accession  
38                     No. ML22031A289)
- 39   March 4, 2022    Letter from NRC to Ms. Deborah Dotson, President, Delaware Nation,  
40                      Request to Initiate Section 106 Consultation and Scoping Process for the  
41                      Kairos Hermes Non-Power Test Reactor Construction Permit Review in  
42                      Roane County, Tennessee. (Accession No. ML22031A289)

- 1    March 11, 2022    Letter to NRC from E. Patrick McIntyre, Jr., Tennessee Historical  
2                         Commission, Regarding Construction of Kairos Power, LLC. Hermes  
3                         Non-Power Test Reactor, ETTP, Oak Ridge, Roane County, TN.  
4                         (Scoping Comment) (Accession No. ML22082A294)
- 5    March 31, 2022    Letter to NRC from Lisa Johnson., Chickasaw Nation, Regarding Kairos  
6                         Hermes Construction Permit. (Scoping Comment) (Accession No.  
7                         ML22090A055)
- 8    March 31, 2022    Email from NRC to Darrel Gardner, Kairos Power, Transmittal of  
9                         Requests for Confirmatory Information for the Review of the Hermes  
10                        Environmental Report. (Package Accession No. ML22090A060)
- 11   April 4, 2022      Letter to NRC from Paul Barton., Eastern Shawnee Tribe of Oklahoma,  
12                         Project Review, Kairos Power Hermes Non-Power Test Reactor  
13                         Construction Permit. (Scoping Comment) (Accession No. ML22094A125)
- 14   April 4, 2022      Email to NRC from Erin Thompson-Paden, Delaware Nation, Regarding  
15                         Kairos Hermes Construction Permit. (Scoping Comment) (Accession No.  
16                         ML22095A221)
- 17   April 4, 2022      Email to NRC from Larry Haikey, Poarch Band of Creek Indians,  
18                         Regarding Kairos Power Hermes Non-Power Test Reactor Construction  
19                         Permit Review. (Scoping Comment) (Accession No. ML22095A224)
- 20   April 6, 2022      Email to NRC from Ben Yahola, Seminole Nation of Oklahoma,  
21                         Regarding Kairos Power Hermes Non-Power Test Reactor Construction  
22                         Permit Review. (Scoping Comment) (Accession No. ML22109A188)
- 23   April 12, 2022     Letter to NRC from Niki Nicholas, Manhattan Project National Park,  
24                         Regarding Kairos Hermes Construction Permit. (Scoping Comment)  
25                         (Accession No. ML22105A022)
- 26   April 15, 2022     E-mail to NRC from Steven Alexander, U.S. Fish & Wildlife Service,  
27                         Regarding Kairos Power, LLC Hermes Reactor at DOE ORR ETTP  
28                         (Heritage Center) (Scoping Comment) (Accession No. 22119A261)
- 29   April 22, 2022     Letter to NRC from Peter Hastings, Kairos Power, Transmittal of  
30                         Responses to NRC Requests for Confirmatory Information for the Review  
31                         of the Hermes Environmental Report. (Package Accession No.  
32                         ML22115A204)
- 33   April 27, 2022     Letter to NRC from Peter Hastings, Kairos Power, Transmittal of  
34                         Supplemental Information for NRC Information Need HCUL-10 for the  
35                         Hermes Environmental Review. (Package Accession No. ML22117A215)
- 36   April 27, 2022     Letter to NRC from Peter Hastings, Kairos Power, Transmittal of Changes  
37                         to Hermes Environmental Report Resulting from NRC Environmental  
38                         Review Audit. (Package Accession No. ML22117A218)

1 May 5, 2022 NRC Memorandum: Summary of March 23, 2022 Public Outreach  
2 Meeting on the Proposed Kairos Hermes Test Reactor with Designated  
3 Period for Receipt of Environmental Scoping Comments (Package  
4 Accession No. ML22110A018)

5 June 30, 2022 Letter to NRC from Peter Hastings, Kairos Power, Transmittal of Changes  
6 to the Construction Permit Application. (Package Accession No.  
7 ML22181B157)

8 August 01, 2022 Environmental Impact Statement Scoping Process Summary Report:  
9 Kairos Hermes Test Reactor Construction Permit Application (Package  
10 Accession No. ML22194A014)

11 August 24, 2022 NRC Memorandum: Summary Report for the Environmental Audit of the  
12 Kairos Hermes Test Reactor Construction Permit Application (Package  
13 Accession No. ML22196A387)

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## APPENDIX D

### **REGULATORY COMPLIANCE AND LIST OF FEDERAL, STATE, AND LOCAL PERMITS AND APPROVALS**

- 5     Table D-1 contains a list of the environmental-related authorizations, permits, and certifications  
6     potentially required by Federal, State, regional, local, and affected Native American Tribal  
7     agencies related to site preparation, construction, and operation of two or more small modular  
8     reactors at the Kairos Hermes nuclear site.
- 9     Table D-1 was adapted from Table 1.4-1 of the Environmental Report submitted to the U.S.  
10    Nuclear Regulatory Commission by the applicant (Kairos 2021-TN7880).

**Table D-1 Authorizations Required for Preconstruction, Construction, and Operation Activities**

<b>Agency</b>	<b>Authority</b>	<b>Requirement</b>	<b>Activity Covered</b>
U.S. Nuclear Regulatory Commission	Atomic Energy Act 10 CFR 50.50Atomic Energy Act 10 CFR 50.50	Construction Permit 50.57	Construction of the facilities
	10 CFR 50.5710 CFR 50.57	Operating License	Operation of the facilities
	10 CFR Part 4010 CFR Part 40	Source Material License	Possession, use, and transfer of special nuclear material
	10 CFR Part 3010 CFR Part 30	By-Product Material License	Production, possession, and transfer of radioactive by-product material
	10 CFR Part 7010 CFR Part 70	Special Nuclear Material License	Receipt, possession, use, and transfer of special nuclear material
National Environmental Policy Act (NEPA)	National Environmental Policy Act (NEPA) 10 CFR Part 51National Environmental Policy Act (NEPA) 10 CFR Part 51	Environmental Assessment or Environmental Impact Statement in accordance with NEPA	Site approval for construction and operation of a radiation facilities
Federal Aviation Administration	Federal Aviation Act 14 CFR Part 77Federal Aviation Act 14 CFR Part 77	Construction Notice	Construction of structures that may impact air navigation (height greater than 200 feet [ft]), construction of structures above a 1 to 100 slope from nearest runway
U.S. Environmental Protection Agency	Resource Conservation and Recovery Act 40 CFR Part 261 and 262	Acknowledgement of Notification of Hazardous Waste Activity	Generation of hazardous waste
	Clean Water Act 40 CFR Part 112 Appendix F	Spill Prevention, Control, and Countermeasure Plans for Construction and Operation	Storage of oil during construction and operation
U.S. Fish and Wildlife Service	Endangered Species Act	Section 7 Consultation	Protection of endangered and threatened species and critical habitats designated under the Federal Endangered Species Act

<b>Agency</b>	<b>Authority</b>	<b>Requirement</b>	<b>Activity Covered</b>
U.S. Department of Transportation	Hazardous Material Transportation Act	Certificate of Registration	Transportation of hazardous materials
Tennessee Department of Environment and Conservation (TDEC)	Federal Clean Air Act	Air Pollution Control Construction Permit	Construction of an air pollution emission source that is not specifically exempted
		Air Pollution Control Operation Permit	Operation of an air pollution emission source that is not specifically exempted
	Federal Clean Water Act	Construction Storm Water Discharge Permit	Discharge of stormwater runoff from the construction site
		Industrial Storm Water Discharge Permit	Discharge of stormwater runoff from the site during facilities operation
Tennessee Department of Safety and Professional Services		Building Plan Review	Compliance with state building codes; required before local building permit can be issued for a commercial building
Tennessee Department of Transportation (TDOT)	Permit for Connection to State Trunk Highway	Permit for Connection to State Trunk Highway	Construction of driveway connection to Highway 58
		Right-of-Entry Permit	Construction by the City of Oak Ridge of Utility Extensions across Highway 58
City of Oak Ridge	Site Plan Approval	Site Plan Approval	Administrative approval of site layout, plans for parking, landscaping, lighting, etc.
		Storm Water Plan approval (may be included in Site Plan Approval)	Administrative approval of grading and drainage plans
		Erosion Control Permit (may be included in Site Plan Approval)	Administrative approval of erosion control plans
		Building Permit	Construction of buildings
		Plumbing Plan Approval	Installation of plumbing systems
		Heating, Ventilation, and Air Conditioning Plan approval	Installation of heating, ventilation, and air conditioning systems
	Occupancy Permit	Occupancy of completed buildings	
	Conditional use Permit	Construction of multiple buildings on the same site	

<b>Agency</b>	<b>Authority</b>	<b>Requirement</b>	<b>Activity Covered</b>
Tennessee State Historic Preservation Office Tribal Historic Preservation Officer	Section 106 of the National Historic Preservation Act	Sanitary Sewer and Water Supply Facility Approvals  National Historic Preservation Act Section 106 compliance and consultation, which includes State Historic Preservation Office/Tribal Historic Preservation Officer, and identification of potentially affected resources, i.e., a site survey	Administrative approval of construction, installation, and operation of connections to the municipal sewer and water supply systems  Protection of archaeological and historical resources

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## APPENDIX E

### GREENHOUSE GAS EMISSIONS

4 The U.S. Nuclear Regulatory Commission (NRC) staff estimated the greenhouse gas (GHG)  
5 emissions of various activities associated with the building, operating, and decommissioning of  
6 nuclear power plants (NPPs). The GHG emission estimates include direct emissions from  
7 nuclear facilities and indirect emissions from workforce and fuel transportation,  
8 decommissioning, and the uranium fuel cycle. The estimates are based on a single installation  
9 of 1,000 megawatt electric (MWe) output with an 80 percent capacity factor henceforth referred  
10 to as the reference 1,000 MWe reactor. The estimates may be roughly linearly scaled from the  
11 reference 1,000 MWe reactor for other reactor outputs.<sup>1</sup> This appendix discusses the  
12 calculation of GHG emission estimates for the reference 1,000 MWe reactor.

13 The estimated emissions from equipment used to build a NPP listed in Table E-1 are based on  
14 hours of equipment use estimated for a single NPP at a site requiring a moderate amount of  
15 terrain modification (UniStar 2007-TN1564). Construction equipment carbon monoxide (CO)  
16 emission estimates were derived from the hours of equipment use, and carbon dioxide (CO<sub>2</sub>)  
17 emissions were then estimated from the CO emissions using a scaling factor of 172 tons (T) of  
18 CO<sub>2</sub> per ton of CO (Chapman et al. 2012-TN2644). The scaling factor is based on the ratio of  
19 CO<sub>2</sub> to CO emission factors for diesel fuel industrial engines as reported in Table 3.3-1 of AP-42  
20 Compilation of Air Pollutant Emission Factors (EPA 2012-TN2647). A CO<sub>2</sub> to total GHG  
21 equivalency factor of 0.991 is used to account for the emissions from other GHGs, such as  
22 methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) (Chapman et al. 2012-TN2644). The equivalency factor  
23 is based on non-road/construction equipment in accordance with relevant guidance (NRC 2014-  
24 TN3768; Chapman et al. 2012-TN2644). Equipment emissions estimates for decommissioning  
25 are assumed to be one-half of those for construction equipment. Data on equipment emissions  
26 for decommissioning are not available; the one-half factor is based on the assumption that  
27 decommissioning would involve less earthmoving and hauling of material, as well as fewer labor  
28 hours, compared to those involved in building activities (Chapman et al. 2012-TN2644).

29 Table E-2 lists the NRC staff's estimates of the CO<sub>2</sub> equivalent<sup>2</sup> (CO<sub>2</sub>eq) emissions associated  
30 with workforce transportation. Construction workforce estimates for the reference 1,000 MWe  
31 reactor are conservatively based on estimates in various combined license applications  
32 (Chapman et al. 2012-TN2644), and the operational and decommissioning workforce estimates  
33 are based on Supplement 1 to NUREG-0586 (NRC 2002-TN665). Table E-2 lists the  
34 assumptions used to estimate total miles (mi) traveled by each workforce and the factors used  
35 to convert total miles to metric tons of CO<sub>2</sub>eq. The workers are assumed to travel in gasoline-  
36 powered passenger vehicles (cars, trucks, vans, and sport utility vehicles) that get an average  
37 of 21.6 miles per gallon (mi/gal) (9.1 kilometers per liter [km/L]) of gasoline (FHWA 2012-  
38 TN2645). Conversion from gallons of gasoline burned to CO<sub>2</sub>eq is based on U.S.  
39 Environmental Protection Agency (EPA) emission factors (EPA 2012-TN2643).

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<sup>1</sup> The term "model LWR" has also been used to describe a 1,000 MWe light water reactor for the purpose of evaluating the environmental considerations of the supporting fuel cycle to the annual reactor operations (WASH-1248, AEC 1974-TN23). It is assumed there are no significant differences between the 1,000 MWe reactor evaluated in WASH-1248 and the 1,000 MWe reference reactor evaluated in this appendix.

<sup>2</sup> A measure to compare the emissions from various GHGs on the basis of their global warming potential, defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO<sub>2</sub> over a specific time period.

1      **Table E-1 Greenhouse Gases Emissions from Equipment Used in Building**  
 2      **and Decommissioning (Metric Tons of Carbon Dioxide Equivalent**  
 3      **[(MT CO<sub>2</sub>eq)]**

Equipment	Building Total <sup>(a)</sup>	Decommissioning Total <sup>(b)</sup>
Earthwork and dewatering	12,000	6,000
Batch plant operations	3,400	1,700
Concrete	5,400	2,700
Lifting and rigging	5,600	2,800
Shop fabrication	1,000	500
Warehouse operations	1,400	700
Equipment maintenance	10,000	5,000
<b>Total<sup>(c)</sup></b>	<b>39,000</b>	<b>19,000</b>

(a) Based on hours of equipment usage over a 7-year period.

(b) Based on equipment usage over a 10-year period.

(c) Results are rounded to the nearest 1,000 MT CO<sub>2</sub>eq.

4      **Table E-2 Workforce Greenhouse Gases Footprint Estimates**

	Construction Workforce	Operational Workforce	Decommissioning Workforce	SAFSTOR Workforce
Commuting trips (round trips per day)	1,000	550	200	40
Commute distance (miles per round-trip)	40	40	40	40
Commuting days (days per year)	365	365	250	365
Duration (years)	7	40	10	40
Total distance traveled (mi) <sup>(a)</sup>	102,000,000	321,000,000	20,000,000	23,000,000
Average vehicle fuel efficiency <sup>(b)</sup> (mi/gal)	21.6	21.6	21.6	21.6
Total fuel burned <sup>(a)</sup> (gal)	4,700,000	14,900,000	900,000	1,100,000
CO <sub>2</sub> emitted per gallon <sup>(c)</sup> (MT CO <sub>2</sub> )	0.00892	0.00892	0.00892	0.00892
Total CO <sub>2</sub> emitted <sup>(a)</sup> (MT CO <sub>2</sub> )	42,000	133,000	8,000	10,000
CO <sub>2</sub> equivalency factor <sup>(c)</sup> (MT CO <sub>2</sub> /MT CO <sub>2</sub> eq)	0.977	0.977	0.977	0.977
Total GHG emitted <sup>(a)</sup> (MT CO <sub>2</sub> eq)	43,000	136,000	8,000	10,000

Key: SAFSTOR = SAFe STORage; mi = miles; mi/gal= miles per gallon; gal=gallon; MT = metric tons; CO<sub>2</sub>eq = carbon dioxide equivalent.

(a) Results are rounded.

(b) Source: FHWA 2012-TN2645.

(c) Source: EPA 2012-TN2643.

1 Title 10 of the *Code of Federal Regulations* 51.51(a) (10 CFR 51.51[a]; TN250) states that every  
2 environmental report <sup>1</sup> prepared for an early site permit or combined license stage of a light-  
3 water-cooled nuclear power reactor shall use Table S-3, Table of Uranium Fuel Cycle  
4 Environmental Data, as set forth in 10 CFR 51.51(b) (TN250) as the basis for evaluating the  
5 contribution of the environmental effects of uranium fuel-cycle activities to the environmental  
6 costs of licensing the nuclear power reactor. Section 51.51(a) (TN250) further states that Table  
7 S-3 shall be included in the ER and may be supplemented by a discussion of the environmental  
8 significance of the data set forth in the table as weighted in the project-specific analysis for the  
9 proposed facility.

10 Table S-3 of 10 CFR 51.51(b) (TN250) does not directly apply to non-light-water reactors  
11 (LWRs), nor does it provide an estimate of GHG emissions associated with the uranium fuel  
12 cycle; it only addresses pollutants that were of concern when the table was promulgated in the  
13 1970s. However, Table S-3 states that 323,000 megawatt-hour (MWh) is the assumed annual  
14 electric energy use for the Table S-3 reference 1,000 MWe NPP and that this 323,000 MWh of  
15 annual electric energy is assumed to be generated by a 45 MWe coal-fired power plant burning  
16 118,000 MT of coal. These assumptions are based upon 1970s uranium enrichment  
17 technology, which has changed substantially since then. The older, energy-intensive gaseous-  
18 diffusion plants have been replaced with more efficient centrifuge-based systems. The current  
19 operating gas centrifuge uranium enrichment facility in the United States is URENCO-USA  
20 (Louisiana Energy Services), which is located in Eunice, New Mexico. The URENCO-USA  
21 facility does not rely solely upon coal as an energy source (Napier 2020-TN6443). If a  
22 1,000 MWe plant is assumed to operate at 35 percent thermal efficiency and use uranium fuel  
23 enriched to 5 percent in uranium-235 (U-235) with an average burnup of 40,000 megawatt-day  
24 per metric ton (MWd/MT) for 40 years, then it will require about 1,043 T of enriched uranium for  
25 fuel. To produce 1 T of 5 percent enriched uranium with 0.25 percent U-235 in the depleted  
26 uranium stream requires extraction of 10.3 T of natural uranium and 7,923 separative work units  
27 (Napier 2020-TN6443). The 1,043 T of uranium enriched to 5 percent U-235 required over the  
28 40-year life of the 1,000 MWe plant would then require 8,264,000 separative work units.  
29 Because a centrifuge enrichment facility requires about 50 kWh per separative work units (WNA  
30 2020-TN6661), a total of 413,200 MWh is needed to produce 40 years' worth of uranium  
31 enriched to 5 percent U-235 for fuel for the lifetime operation of the 1,000 MWe plant. For the  
32 existing U.S. centrifuge enrichment plant, the regional average CO<sub>2</sub> emission factor is  
33 1,248 pounds per megawatt-hour (lb/MWh),<sup>2</sup> and the total CO<sub>2</sub> emission is about 243,000 MT.

34 Table S-3 also assumes that approximately 135,000,000 standard cubic feet (scf) of natural gas  
35 is required per year to generate process heat for certain portions of the uranium fuel cycle. The  
36 NRC staff estimates that burning 135,000,000 scf of natural gas per year results in  
37 approximately 7,440 MT of CO<sub>2</sub>eq being emitted into the atmosphere per year because of the  
38 process heat requirements of the uranium fuel cycle.<sup>3</sup> For a 40-year operational life, this is  
39 298,000 MT of CO<sub>2</sub>eq. This amount is in addition to the CO<sub>2</sub>eq emissions from the enrichment  
40 process.

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<sup>1</sup> The NRC requires most applicants, including all reactor applicants, to submit an Environmental Report as part of the application. 10 CFR 51.45 and 10 CFR 51.50 [TN250].

<sup>2</sup> The EPA provides estimates of emissions from electricity production for different regions in the United States at <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid> for CO<sub>2</sub> in units of lb/kWh. The value for southeastern New Mexico has been applied here.

<sup>3</sup> The conversion is 0.0551 (MT CO<sub>2</sub>/thousand scf) (<https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>).

1 The NRC staff estimated GHG emissions related to plant operations from the typical usage of  
2 various onsite diesel generators (UniStar 2007-TN1564). CO emission estimates were derived  
3 assuming an average of 600 hours of emergency diesel generator operation per year (four  
4 generators, each operating 150 hours per year [hr/yr]) and 200 hours of station blackout diesel  
5 generator operation per year (two generators, each operating 100 hr/yr) (Chapman et al. 2012-  
6 TN2644). A scaling factor of 172 was then applied to convert the CO emissions to CO<sub>2</sub>  
7 emissions, and a CO<sub>2</sub> to total GHG equivalency factor of 0.991 was used to account for the  
8 emissions from other GHGs such as CH<sub>4</sub> and N<sub>2</sub>O (Chapman et al. 2012-TN2644).

9 The number of shipments and shipping distances for transport of fresh nuclear fuel and spent  
10 nuclear fuel and radioactive wastes are presented in Table S-5 of Supplement 1 to WASH-1238  
11 [NRC 1975-TN216], for a 1,100 MWe LWR with an 80 percent capacity factor. WASH-1248  
12 (AEC 1974-TN23) assumes that truck casks weigh 50,000 pounds (lb) (23 MT) and rail casks  
13 weigh 100 T (91 MT). For this analysis, emission rates of CO<sub>2</sub> for trucks are taken to be 64.7  
14 gram per ton-mile (g/T-mi) (44.2 gram per metric ton-kilometer [g/MT-km]) and for rail are taken  
15 to be 32.2 g/T-mi (22 g/MT-km) (Cefic and ECTA 2011-TN6966). For the calculation, it is also  
16 assumed that return trips with empty casks double the total miles traveled by truck or rail.  
17 Table E-3 presents estimated annual CO<sub>2</sub>eq emissions from shipments associated with the  
18 reference 1,000 MWe reactor.

19 **Table E-3 Annual Number of Shipments for the Reference 1,000 MWe Reactor**

Material	Annual Number of Shipments for the Reference 1,000 MWe Reactor	Typical Distance (mi) <sup>(a)</sup>	Annual CO <sub>2</sub> eq Emissions <sup>(b)</sup>
Unirradiated fuel (truck)	6	1,000	19
Spent fuel (truck)	60	1,000	194
Spent fuel (rail)	10	1,000	64
Radioactive waste (truck)	46	500	74

20 Key: MWe = megawatt electric; mi = mile; CO<sub>2</sub>eq = carbon dioxide equivalent.

21 <sup>(a)</sup> Source: NRC (1975-TN216), Table S-5.

22 <sup>(b)</sup> Results are rounded to the nearest 1,000 MT CO<sub>2</sub>e.

23 The total GHG emissions for fuel and waste transportation are approximately 352 MT per  
24 reference reactor-year from Table E-3. Over a 40-year operating life for the reference  
25 1,000 MWe reactor, the total is approximately 14,000 MT of CO<sub>2</sub>eq emitted.

26 Given the various sources of GHG emissions discussed above, the NRC staff estimated the  
27 total lifetime GHG footprint for the reference 1,000 MWe reactor to be about 990,000 MT  
28 CO<sub>2</sub>eq, with a 7-year building phase, 40 years of operation, and 10 years of active  
29 decommissioning.<sup>1</sup> These components of the GHG emissions footprint are summarized in  
30 Table E-4. The uranium fuel cycle component of the footprint is the largest portion of the overall

<sup>1</sup> Under the NRC's regulations, a reactor licensee has up to 60 years to complete the decommissioning of a reactor facility commencing with the licensee's certification that it has permanently ceased reactor operations (10 CFR 50.82(a)(3); TN249). The 60-year decommissioning period may be exceeded subject to NRC approval, if necessary, to protect "public health and safety." Id. The estimated 10-year decommissioning period is a subset of the 60-year decommissioning period, during which significant demolition and earthmoving activities may occur (e.g., deployment and operation of equipment at the decommissioning site and shipments by truck or rail to remove irradiated soil, rubble, and debris from the site), as discussed in Supplement 1 to NUREG-0586 (NRC 2002-TN665).

1 estimated GHG emissions and is directly related to the assumed power generated by the plant.  
2 The GHG emission estimates for the uranium fuel cycle are based on newer enrichment  
3 technology, assuming that the energy required for enrichment is provided by modern regional  
4 electric systems.

5 **Table E-4 Nuclear Power Plant Life-cycle Greenhouse Gas Footprint**

Source	Activity Duration (in years) <sup>(a)</sup>	Total Emissions (MT CO <sub>2</sub> eq)
Construction equipment	7	39,000
Construction workforce	7	43,000
Plant operations	40	181,000
Operations workforce	40	136,000
Uranium fuel cycle	40	540,000
Fuel and waste transportation	40	14,000
Decommissioning equipment	10	19,000
Decommissioning workforce	10	8,000
SAFSTOR workforce	40	10,000
<b>TOTAL<sup>(b)</sup></b>		<b>990,000</b>

Key: CO<sub>2</sub>eq = carbon dioxide equivalent; SAFSTOR = SAFe STORage.

(a) Nuclear power plant life-cycle for estimating GHG is assumed to be 97 years which includes building, operating, and decommissioning.

(b) Results are rounded to the nearest 1,000 MT CO<sub>2</sub>eq.

6 The Intergovernmental Panel on Climate Change (IPCC) released a special report about  
7 renewable energy sources and climate change mitigation in 2012 (IPCC 2012-TN2648).  
8 Annex II of the IPCC report includes an assessment of previously published works on life cycle  
9 of GHG emissions from various electric generation technologies, including nuclear energy. The  
10 IPCC report included only reference material that passes certain screening criteria for quality  
11 and relevance in its assessment. The IPCC screening yielded 125 estimates of nuclear energy  
12 life cycle GHG emissions from 32 separate references. The IPCC-screened estimates of the life  
13 cycle GHG emissions associated with nuclear energy, as shown in Table A.II.4 of the IPCC  
14 report, ranged from 1 to 220 gram (g) of carbon equivalent per kilowatt hour (CO<sub>2</sub>eq/kWh), with  
15 25th percentile, 50th percentile, and 75th percentile values of 8 g CO<sub>2</sub>eq/kWh, 16 g CO<sub>2</sub>eq/kWh,  
16 and 45 g CO<sub>2</sub>eq/kWh, respectively. The range of the IPCC estimates is due, in part, to  
17 assumptions regarding the type of enrichment technology employed, how the electricity used for  
18 enrichment is generated, the grade of mined uranium ore, the degree of processing and  
19 enrichment required, and the assumed operating lifetime of a NPP. The NRC staff's GHG life  
20 cycle estimate of approximately 990,000 MT CO<sub>2</sub>eq for the reference 1,000 MWe reactor is  
21 equal to about 3.5 g CO<sub>2</sub>eq/kWh, which places the NRC staff's estimate at the lower end of the  
22 IPCC estimates in Table A.II.4 of the IPCC report. This placement is primarily because the  
23 IPCC estimates were for LWRs that used enrichment technologies that were based on the use  
24 of coal-fired generation as the electricity source.

25 The GHG emissions presented in Section 3.0 of this draft EIS use the values presented in this  
26 appendix but are scaled based on project-specific information. The GHG emissions for building,  
27 operation (including the fuel waste and transportation of fuel and waste), and decommissioning  
28 are discussed in Section 3.2.

1    **E.1    References**

- 2    10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic Licensing of  
3    Production and Utilization Facilities." TN249.
- 4    10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental  
5    Protection Regulations for Domestic Licensing and Related Regulatory Functions." TN250.
- 6    AEC (U.S. Atomic Energy Commission). 1974. *Environmental Survey of the Uranium Fuel  
7    Cycle*. WASH-1248, Washington, D.C. ADAMS Accession No. ML14092A628. TN23.
- 8    Cefic and ECTA (European Chemical Industry Council and European Chemical Transport  
9    Association). 2011. *Guidelines for Measuring and Managing CO<sub>2</sub> Emission from Freight  
10   Transport Operations*. Brussels, Belgium. Accessed March 21, 2021, at  
11   [https://www.ecta.com/resources/Documents/Best%20Practices%20Guidelines/guideline\\_for\\_m](https://www.ecta.com/resources/Documents/Best%20Practices%20Guidelines/guideline_for_m)  
12   easuring\_and\_managing\_co2.pdf. TN6966.
- 13   Chapman, E.G., J.P. Rishel, J.M. Niemeyer, K.A. Cort, and S.E. Gulley. 2012. *Assumptions,  
14   Calculations, and Recommendations Related to a Proposed Guidance Update on Greenhouse  
15   Gases and Climate Change*. PNNL-21494, Pacific Northwest National Laboratory, Richland,  
16   Washington. ADAMS Accession No. ML12310A212. TN2644.
- 17   EPA (U.S. Environmental Protection Agency). 2012. "Clean Energy: Calculations and  
18   References." Washington, D.C. ADAMS Accession No. ML12292A648. TN2643.
- 19   EPA (U.S. Environmental Protection Agency). 2012. "Stationary Internal Combustion Sources."  
20   Chapter 3 in *Technology Transfer Network Clearinghouse for Inventories & Emissions Factors:  
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22   ML12292A637. TN2647.
- 23   FHWA (Federal Highway Administration). 2012. "Highway Statistics 2010 (Table VM-1)." Office of Highway Policy Information, Washington, D.C. ADAMS Accession No. ML12292A645.  
24   TN2645.
- 26   IPCC (Intergovernmental Panel on Climate Change). 2012. *Renewable Energy Sources and  
27   Climate Change Mitigation—Special Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom. TN2648.
- 29   Napier, B.A. 2020. *Non-LWR Fuel Cycle Environmental Data*. PNNL-29367, Revision 2,  
30   Richland, Washington. ADAMS Accession No. ML20267A217. TN6443.
- 31   NRC (U.S. Nuclear Regulatory Commission). 1975. *Environmental Survey of Transportation of  
32   Radioactive Materials to and from Nuclear Power Plants, Supplement 1*. NUREG-75/038,  
33   Washington, D.C. ADAMS Accession No. ML14091A176. TN216.

- 1 NRC (U.S. Nuclear Regulatory Commission). 2002. *Final Generic Environmental Impact*  
2 *Statement of Decommissioning of Nuclear Facilities: Regarding the Decommissioning of*  
3 *Nuclear Power Reactors.* NUREG-0586, Supplement 1, Volumes 1 and 2, Washington, D.C.  
4 ADAMS Accession Nos. ML023470327, ML023500228. TN665.
- 5 NRC (U.S. Nuclear Regulatory Commission). 2014. *Attachment 1: Staff Guidance for*  
6 *Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact*  
7 *Statements, COL/ESP-ISG-026.* Washington, D.C. ADAMS Accession No. ML14100A157.  
8 TN3768.
- 9 UniStar (UniStar Nuclear Energy, LLC). 2007. *Technical Report in Support of Application of*  
10 *UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for Certificate of*  
11 *Public Convenience and Necessity Before the Maryland Public Service Commission for*  
12 *Authorization to Construct Unit 3 at Calvert Cliffs Nuclear Power Plant and Associated*  
13 *Transmission Lines.* Public Service Commission of Maryland, Baltimore, Maryland. ADAMS  
14 Accession No. ML090680053. TN1564.
- 15 WNA (World Nuclear Association). 2020. "Uranium Enrichment." London, United Kingdom.  
16 Webpage accessed October 16, 2020, at <https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/uranium-enrichment.aspx>.  
18 TN6661.  
19



1 APPENDIX F  
2  
3 **VIEWSHED PHOTOGRAPHS AT NEARBY HISTORIC AND CULTURAL**  
4 **RESOURCES**



KP-NRC-2204-008

April 27, 2022

Docket No. 50-7513

US Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Subject: Kairos Power LLC  
Transmittal of Supplemental Information for NRC Information Need HCUL-10 for  
the Hermes Environmental Review

References: 1. Letter, Kairos Power LLC to Document Control Desk "Submittal of the Environmental Report for the Kairos Power Fluoride Salt-Cooled, High Temperature Non-Power Reactor (Hermes)," October 31, 2021 (ML21306A131)  
2. Email, Nuclear Regulatory Commission, Tamsen Dozier to Kairos Power LLC, "Kairos Power, LLC Hermes Environmental Report Audit Plan," February 2, 2022 (ML22052A008)

By letter dated October 31, 2021 (Reference 1), Kairos Power LLC submitted its Environmental Report (ER) in support of the construction permit application (CPA) for the Hermes test reactor. As part of the Nuclear Regulatory Commission (NRC) review of the information contained in the ER, NRC announced (Reference 2) and conducted an audit of the Hermes ER.

During the audit, the NRC requested that Kairos Power provide supplemental information related to audit information need HCUL-10 (Reference 2). The enclosure to this letter submits photographs taken in the Hermes site vicinity, specifically requested by NRC staff during the audit. Kairos Power requests NRC staff review of this information in support of continued review of the Hermes non-power test reactor CPA.

If you have any questions or need any additional information, please contact Marty Bryan at bryan@kairospower.com or at (865) 369-1136, or Darrell Gardner at gardner@kairospower.com or (704) 769-1226.

I declare under penalty of perjury that the foregoing is true and correct.  
Executed on April 27, 2022.

A handwritten signature in black ink, appearing to read "Peter Hastings".

Peter Hastings, PE  
Vice President, Regulatory Affairs and Quality

Enclosure: Supplemental Information for HCUL-10 for Hermes Environmental Review

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**Enclosure 1**  
**Supplemental Information for HCUL-10 for Hermes Environmental Review**

**(Non-Proprietary)**



**NRC Question Number: HCUL-10**

In ER Section 4.6.1, it states that the nearest listed National Register of Historic Places property is the K-25 Gaseous Diffusion Plant which is part of the Manhattan Project National Park. The ER states that "...given the intervening structures between the site and the K-25 Plant as well as the low profile of the proposed structures on the site, no visual or other indirect impacts occur." Please describe or discuss any architectural surveys conducted for the proposed project to assess indirect (i.e., visual) effects to other historic and cultural resources (i.e., historic properties) within the viewshed/indirect effects APE?

**Kairos Power Response:**

During the audit, the NRC requested, and Kairos Power agreed to submit to the docket, supplemental information related to this Audit Information Need Historic and Cultural Resources (HCUL)-10. Specifically, photographs are provided to assess the indirect (i.e., visual) effects to selected historic and cultural resources (i.e., historic properties) within the proposed site viewshed. The following eight photographs were recently taken from the historic and cultural properties in the site vicinity, in the direction of the proposed Hermes facility.

All photographs were taken on March 24, 2022.

**Impact on Licensing Document:**

This information does not result in changes to the Hermes Environmental Report.

**Photo 1 - Gallaher Cemetery (Front)**



Photo 1, taken at the Gallaher Cemetery entrance and facing toward the Hermes site

Photo 2 - Gallaher Cemetery (Back)



Photo 2, taken at the back of the Gallaher Cemetery, facing toward the Hermes site

Photo 3 - African Burial Ground



Photo 3, taken from the African Burial Ground, facing toward the Hermes site

1

Photo 4 – Wheat Community African Burial Ground (Marker)



Photo 4, taken at the site of the Wheat Community African Burial Ground Marker, facing toward the Hermes site

Photo 5 - Wheat Community Historic Marker



Photo 5, taken at the Wheat Community Historic Marker, facing toward the Hermes site

**Photo 6 - George Jones Memorial Baptist Church**



Photo 6, taken near the George Jones Memorial Baptist Church entrance, facing toward the Hermes site

Photo 7 - Ellis Cemetery



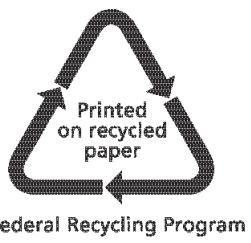
Photo 7, taken from the Ellis Cemetery fenceline, facing toward the Hermes site

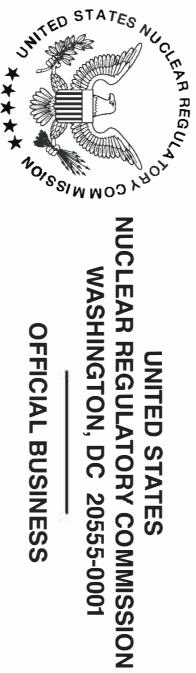
**Photo 8 - K-25 Proposed Viewing Platform Site**



Photo 8, taken from the proposed site of the K-25 Viewing Platform, facing toward the  
Hermes site

<b>NRC FORM 335</b> (12-2010) NRCMD 3.7		<b>U.S. NUCLEAR REGULATORY COMMISSION</b>	
<b>BIBLIOGRAPHIC DATA SHEET</b> <i>(See instructions on the reverse)</i>			
<b>2. TITLE AND SUBTITLE</b> Environmental Impact Statement for the Construction Permit for the Kairos Hermes Test Reactor		<b>1. REPORT NUMBER</b> (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG-2263 Draft	
		MONTH	YEAR
		September	2022
		<b>4. FIN OR GRANT NUMBER</b>	
<b>5. AUTHOR(S)</b> See Appendix A		<b>6. TYPE OF REPORT</b> Technical	
		<b>7. PERIOD COVERED (Inclusive Dates)</b>	
<b>8. PERFORMING ORGANIZATION - NAME AND ADDRESS</b> (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.) Division of Rulemaking, Environmental, and Financial Support Office of Nuclear Material Safety and Safeguards U.S. Nuclear Regulatory Commission Washington, D.C. 20555-0001			
<b>9. SPONSORING ORGANIZATION - NAME AND ADDRESS</b> (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.) Same as above			
<b>10. SUPPLEMENTARY NOTES</b> Docket 50-7513			
<b>11. ABSTRACT</b> (200 words or less) <p>This draft environmental impact statement (EIS) has been prepared in response to an application to the U.S. Nuclear Regulatory Commission (NRC) by Kairos Power, LLC (Kairos) for construction permit (CP) for a non-power research and test reactor termed Hermes at a site in Oak Ridge, Tennessee. Kairos plans to build and operate Hermes to demonstrate key elements of the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor (KP-FHR) technology for possible future commercial deployment. This draft EIS includes the analysis that evaluates the environmental impacts of the proposed action and considers the following two alternatives to the proposed action: (1) the no-action alternative (i.e., the CP is denied) and (2) building the proposed Hermes non-power research and test reactor at a site near Idaho Falls, Idaho.</p> <p>After weighing the environmental, economic, technical, and other benefits against environmental and other costs, the NRC staff's preliminary recommendation, unless safety issues mandate otherwise, is that the operating license be issued as proposed. The NRC staff based its recommendation on the following:</p> <ul style="list-style-type: none"> <li>•the application, including the Kairos Hermes environmental report and supplemental submittals;</li> <li>•consultation with Federal, State, Tribal, and local agencies;</li> <li>•consideration of public comments; and</li> <li>•the staff's independent review.</li> </ul>			
<b>12. KEY WORDS/DESCRIPTORS</b> (List words or phrases that will assist researchers in locating the report.) Kairos Hermes Test Reactor Kairos Power Hermes Non-Power Test Reactor Draft Environmental Impact Statement, DEIS National Environmental Policy Act, NEPA NUREG-2263		<b>13. AVAILABILITY STATEMENT</b> unlimited	
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