

**Enclosure 1**

**Presentation Materials for Meeting on Kairos Power Future Plans**

(Note that the enclosed information is preliminary and pre-decisional and is subject to change during detailed planning and project execution. It is provided for planning and familiarization purposes in support of pre-application discussions with the NRC Staff.)




# Kairos Power

## Hermes 2 Pre-Application Engagement

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PUBLIC MEETING

JUNE 28, 2023



Kairos Power's mission is to enable the world's transition to clean energy, with the ultimate goal of dramatically improving people's quality of life while protecting the environment.

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In order to achieve this mission, we must prioritize our efforts to focus on a clean energy technology that is *affordable* and *safe*.

# Introduction

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- Kairos Power intends to submit a construction permit application (CPA) for a two-unit test reactor named Hermes 2 in July 2023
- Hermes 2 will be licensed as a test reactor under the provisions of 10 CFR 50.21(c) and Atomic Energy Act Section 2134(c) to test and demonstrate:
  - An intermediate (salt) heat transport loop between the primary and power generation systems
  - Shared electrical power production and power generation system
  - An increased component lifetime and/or component replacement capability
- Kairos Power will be requesting an accelerated review due to similarities found with the design and siting information found in the Hermes CPA
  - The final safety evaluation report released in June 2023
  - The final environmental impact statement expected in summer 2023

# Key Differences between Hermes and Hermes 2

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- Hermes 2 (Unit 1 and Unit 2) will be identical to Hermes except for the following high-level changes:
  - Two reactor unit facility
  - Licensed lifetime is 11 years
  - Hermes 2 will transmit electrical power
  - Some sharing of SSCs
    - No sharing of safety-related SSCs
    - The two units will share a power generation system
    - Some sharing of other non-safety related SSCs
  - Each unit will use an intermediate salt loop to exchange heat from the primary salt to the common power generation system
  - Additional tritium management strategies due to addition of intermediate loop and power generation system
  - Additional hazards considered in safety analysis
- An overview of the content in each Hermes 2 CPA chapter is presented in the following slides with respect to the deltas between Hermes and Hermes 2

# Hermes 2 PSAR Chapters Identical to Hermes PSAR

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- Hermes 2 PSAR chapters 4, 6, 10, 15, 16, 17, and 18 have no substantive changes from the Hermes PSAR, and should require little to no new review effort.
  - Chapter 4 – Design of reactor core, reactor vessel system, biological shield, nuclear, thermal hydraulic, and reactor vessel structural support for each Hermes 2 unit are identical to Hermes.
  - Chapter 6 – The functional containment strategy and decay heat removal system (DHRS) design for each Hermes 2 unit are identical to Hermes.
  - Chapter 10 – Like Hermes, the Hermes 2 facility will not include dedicated experimental facilities.
  - Chapter 15 – The financial commitments in Hermes 2 Chapter 15 are identical to those in Hermes. However, updated financial information will be enclosed with the Hermes 2 CPA to provide assurance that costs related to construction and fuel cycle can be covered.
  - Chapters 16, 17, 18 – Like Hermes, these sections are not applicable to the Hermes 2 CPA.

# PSAR Chapter 1: The Facility

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- Hermes 2 PSAR Chapter 1 Format
  - 1.1 Introduction
  - 1.2 Summary and Conclusions of Principal Safety Considerations
  - 1.3 General Description of the Facility
  - 1.4 Shared Facilities and Equipment
  - 1.5 Comparison with Similar Facilities
  - 1.6 Summary of Operations
  - 1.7 Compliance with the Nuclear Waste Policy Act of 1982
  - 1.8 Facility Modifications and History
- Hermes 2 PSAR content that is different from Hermes
  - Chapter 1 is mostly a summary chapter. The content that differs from Hermes PSAR Ch. 1 is related to the design and operating characteristic changes described throughout the rest of the Hermes 2 PSAR.



# PSAR Chapter 2: Site Characteristics

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- Hermes 2 PSAR Chapter 2 Format
  - 2.1 Geography and Demography
  - 2.2 Nearby Industrial, Transportation, and Military Installations
  - 2.3 Meteorology
  - 2.4 Hydrology
  - 2.5 Geology, Seismology, and Geotechnical Engineering
- Hermes 2 PSAR content that is different from Hermes
  - There are two safety-related reactor buildings. Each reactor building has the same dimensions as the Hermes reactor building.
  - The Hermes 2 reactor buildings are located to the north of the Hermes facility on the K-33 site.
  - The foundation of Hermes 2 is located near the due diligence borings from the Hermes facility.
  - Updated demography, nearby installations, and meteorology data.



# PSAR Chapter 3: Design of Structures, Systems, and Components

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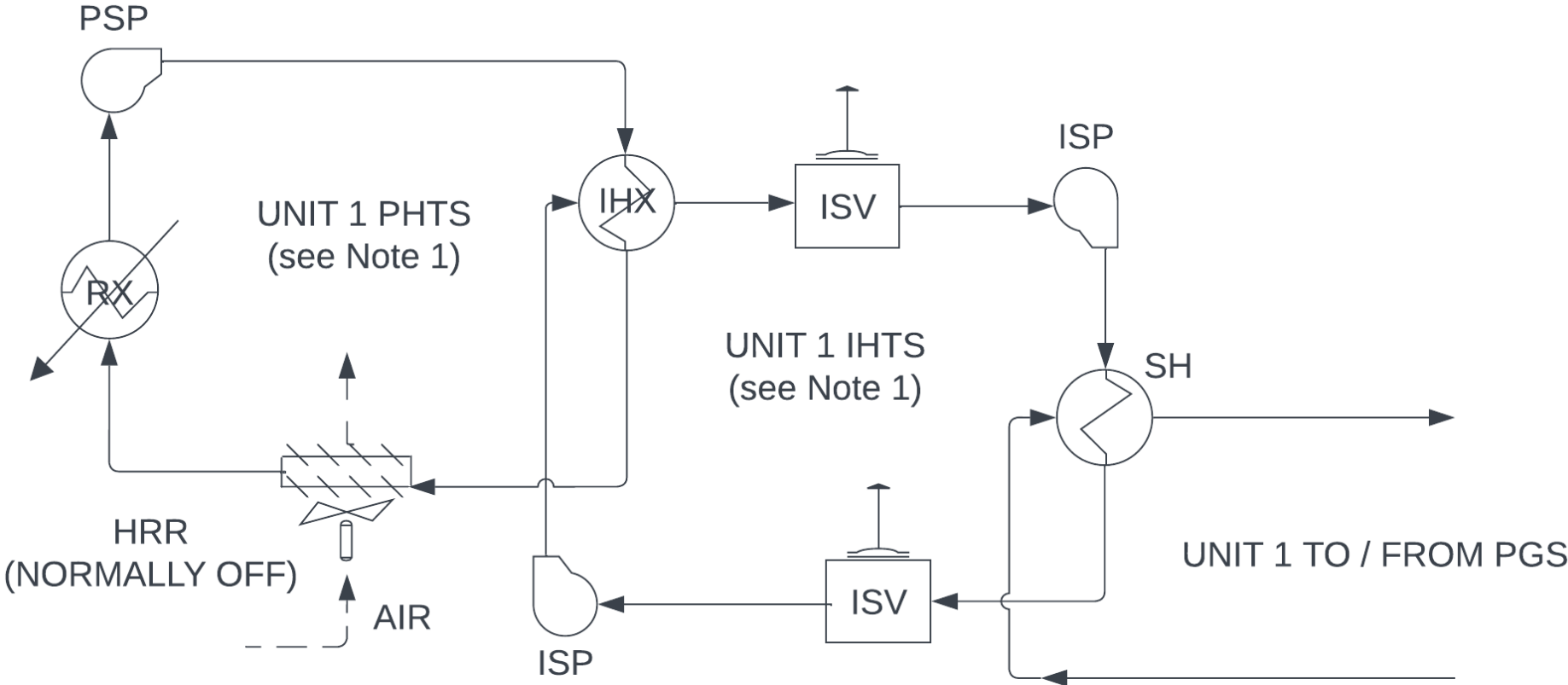
- Hermes 2 PSAR Chapter 3 Format
  - 3.1 Introduction
  - 3.2 Meteorological Damage
  - 3.3 Water Damage
  - 3.4 Seismic Damage
  - 3.5 Plant Structures
  - 3.6 Systems and Components
- Hermes 2 PSAR content that is different from Hermes
  - Although the facility contains two reactor units, there are no safety-related systems shared between the two units, which satisfies PDC 5.
  - There is an updated schematic to display the reactor building major components.
  - The applicable 10 CFR Regulations, Principal Design Criteria, and structures, systems, and components list were updated to include the new systems for intermediate loop and power generation.

# PSAR Chapter 5: Heat Transport System (1/2)

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- Hermes 2 PSAR Chapter 5 Format
  - 5.1 Primary Heat Transport System (PHTS)
  - 5.2 Intermediate Heat Transport System (IHTS)
- Hermes 2 PSAR content that is different from Hermes
  - The primary heat transport system
    - The reactor coolant is circulated through an intermediate heat exchanger (IHX) rather than a heat rejection radiator
    - A smaller heat rejection radiator is included in the PHTS for low power startup and normal shutdown conditions
  - The intermediate heat transport system
    - Intermediate coolant, or (BeNaF) is a mixture of sodium fluoride and beryllium fluoride
      - BeNaF is chemically compatible with Flibe
    - Intermediate salt pumps circulate BeNaF between the IHX and power generation system interfaces
    - Capability provided for tritium capture
      - Tritium management strategies discussed in Chapter 9 slides

# PSAR Chapter 5: Heat Transport System (2/2)



Note 1: Duplicated and separate Unit 2 PHTS and Unit 2 IHTS to/from common PGS

# PSAR Chapter 7: Instrumentation and Controls

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- Hermes 2 PSAR Chapter 7 Format
  - 7.1 Instrumentation and Controls Overview
  - 7.2 Plant Control System
  - 7.3 Reactor Protection System
  - 7.4 Main Control Room and Remote Onsite Shutdown Panel
  - 7.5 Sensors
- There are no design changes to the reactor protection system (RPS).
- Hermes 2 PSAR content that is different from Hermes
  - Portions of the non-safety related I&C plant control system (PCS) are shared between Unit 1 and Unit 2.
  - The plant control system has two new subsystems.
    - Intermediate heat transport control system (not shared)
    - Power generation control system (shared)
  - The main control room is configured for two-unit operations. The building is shared.

# PSAR Chapter 8: Electric Power Systems

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- Hermes 2 PSAR Chapter 8 Format
  - 8.1 Summary Description
  - 8.2 Normal Power System
  - 8.3 Backup Power System
- Hermes 2 PSAR content that is different from Hermes
  - The non-safety related electrical power system only includes changes that incorporate the two-unit facility and power generation capabilities
  - The AC power and backup generators are shared between Unit 1 and Unit 2
  - AC power generated from the turbine generator system is provided to an onsite switchyard and distributed to the offsite electrical grid
    - The switchyard is protected to mitigate fault risk

# PSAR Chapter 9: Auxiliary Systems (1/4)

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- Hermes 2 PSAR Chapter 9 Format
  - 9.1 Reactor Coolant Auxiliary Systems
  - 9.2 Reactor building heating, venting, and air conditioning systems
  - 9.3 Pebble Handling and Storage Systems
  - 9.4 Fire Protection Systems and Programs
  - 9.5 Communication
  - 9.6 Possession and Use of Byproduct, Source, and Special Nuclear Material
  - 9.7 Plant Water System
  - 9.8 Other Auxiliary Systems
  - 9.9 Power Generation System

# PSAR Chapter 9: Auxiliary Systems (2/4)

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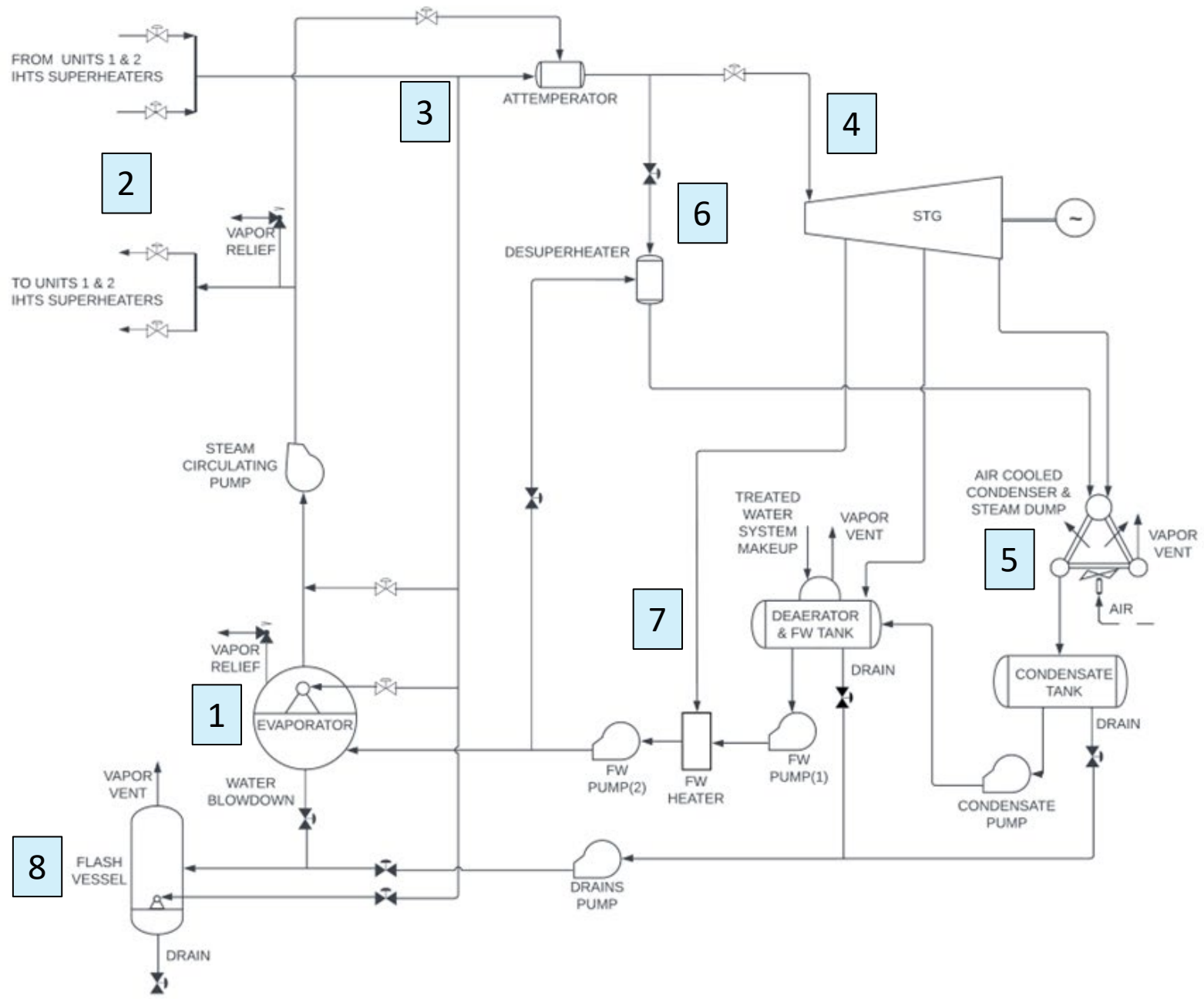
- Hermes 2 PSAR content that is different from Hermes
  - Two additional tritium management functions are added to Hermes 2:
    - Tritium capture from IHTS cover gas
    - Tritium capture from HRR
      - During normal power operations – tritium captured from the HRR enclosure.
      - During low-power startup and normal shutdown – tritium discharged as a gaseous effluent.
  - Shared non-safety related auxiliary systems:
    - Fire protection systems
    - Communication systems
    - Service water system
    - Treated water system
    - Auxiliary site services
    - Power generation system



# PSAR Chapter 9: Auxiliary Systems (3/4)

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- The power generation system uses heat energy from the IHTS to convert thermal energy into electrical energy.
- The PGS includes:
  - Steam system
    - Recirculated superheated steam from IHTS
    - Evaporator and circulating steam pump
    - Flash vessel
  - Turbine generator system
    - Steam turbine and generator
    - Attemperator
    - Turbine bypass line
  - Condensate and feedwater system
    - Air-cooled condenser and condensate tank
    - Deaerator and feedwater tank
    - Feedwater pumps
    - Feedwater heater



## Power Generation Systems

# PSAR Chapter 11: Radiation Protection and Waste Management

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- Hermes 2 PSAR Chapter 11 Format
  - 11.1 Radiation Protection
  - 11.2 Radioactive Waste Management
- Hermes 2 PSAR content that is different from Hermes
  - Hermes normal radiological effluent screening analysis evaluated for Hermes 2
    - Considers new potential gaseous effluent release points including the power generation system evaporator, flash vessel, deaerator, and condenser vent pipes
    - Dose from Hermes analysis is doubled to account for both units of Hermes 2
  - Total site emissions include contributions from the Hermes demonstration facility
  - Results of screening analysis demonstrate that doses from all site effluents are below Part 20 limits for individual members of the public

# PSAR Chapter 12: Conduct of Operations

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- Hermes 2 PSAR Chapter 12 Format
  - 12.1 Organization
  - 12.2 Review and Audit Activities
  - 12.3 Procedures
  - 12.4 Required Actions
  - 12.5 Reports
  - 12.6 Records
  - 12.7 Emergency Planning
  - 12.8 Security
  - 12.9 Quality Assurance
  - 12.10 Reactor Operator Training and Requalification
  - 12.11 Startup Plan
  - 12.12 References
- Hermes 2 PSAR content that is different from Hermes
  - Staffing other than operating crew is shared between units.

# PSAR Chapter 13: Accident Analysis (1/3)

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- Hermes 2 PSAR Chapter 13 Format
  - 13.1 Initiating Events and Scenarios
  - 13.2 Accident Analysis and Determination of Consequences
  - 13.3 References
- Hermes 2 uses the same Maximum Hypothetical Accident (MHA) as described in the Hermes PSAR.
- The MHA and postulated events presented in Chapter 13 apply to each unit and are evaluated against the siting criteria for each unit separately.
  - This is consistent with the requirements in 10 CFR 100.11(b) for multiple reactor facilities where the reactors are independent to the extent that a postulated event for one unit does not affect the safety of operation of the other unit
    - 10 CFR 100.11(b)(1-2) - *For sites for multiple reactor facilities consideration should be given to the following:*
      - (1) *If the reactors are **independent to the extent that an accident in one reactor would not initiate an accident in another**, the size of the exclusion area, low population zone and population center distance shall be fulfilled with respect to each reactor individually. The envelopes of the plan overlay of the areas so calculated shall then be taken as their respective boundaries.*
      - (2) *If the reactors are **interconnected to the extent that an accident in one reactor could affect the safety of operation of any other**, the size of the exclusion area, low population zone and population center distance shall be based upon the assumption that all interconnected reactors emit their postulated fission product releases simultaneously. This requirement may be reduced in relation to the degree of coupling between reactors, the probability of concomitant accidents and the probability that an individual would not be exposed to the radiation effects from simultaneous releases. The applicant would be expected to justify to the satisfaction of the Commission the basis for such a reduction in the source term.*

# PSAR Chapter 13: Accident Analysis (2/3)

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- Hermes 2 PSAR content that is different from Hermes
  - The new technical report "Hermes 2 Postulated Event Analysis Methodology" will be submitted with the CPA to include new postulated events
  - New potential hazards and initiating events are considered for the intermediate coolant, intermediate heat transport system, and power generation system
    - New initiators for increase in heat removal events include ISP overspeed, spurious opening of a turbine bypass valve or steam safety valve, superheater shell leak, steam line break, and spurious actuation of the heat rejection radiator
    - New events grouped under the salt spill postulated event include leaks from the IHTS and IHX tube break or leak
    - New initiators for loss of normal heat sink events include ISP failure and superheater tube rupture

# PSAR Chapter 13: Accident Analysis (3/3)

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- (cont'd) New potential hazards and initiating events are considered for the intermediate coolant, intermediate heat transport system, and power generation system
  - New systems included in the radioactive release from subsystem or component postulated event include the IHTS and power generation system
  - Faults in the IHTS are included within the general challenges to normal operation postulated event group
  - New internal hazard events include turbine missile and high energy steam line break, though potential impact of these hazards on safety-related functions are precluded by design and location of the power generation system
  - IHX failure due to superheater tube rupture or leak is added to the prevented events (Section 13.1.10)



# PSAR Chapter 14: Technical Specifications

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- Hermes 2 PSAR Chapter 14 Format
  - 14.1 Introduction
  - 14.2 Operating Modes
  - 14.3 References
- Hermes 2 PSAR content that is different from Hermes
  - The LCO for materials at risk includes the intermediate heat transport system and power generation system.
  - Added new LCOs for operability of IHTS overpressure relief devices, quantity of Flibe in the intermediate coolant, and quantity of water in the intermediate coolant.

# Environmental Report Overview

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- Hermes 2 Environmental Report (ER)
  - Chapter 1 Introduction
  - Chapter 2 Proposed Action
  - Chapter 3 Description of the Affected Environment
  - Chapter 4 Impacts of Proposed Construction, Operations, and Decommissioning
  - Chapter 5 Alternatives
  - Chapter 6 Conclusions
  - Transmission Line Appendix
- Rather than include redundant information from the Hermes ER, the Hermes 2 ER only includes content where information has been changed or added.
  - Information from the Hermes ER is incorporated by reference into the Hermes 2 ER, in alignment with guidance given in the Interim Staff Guidance augmenting NUREG-1537, Part 1.

# ER Chapter 1: Introduction

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- Hermes 2 ER Chapter 1 Format
  - 1.1 Introduction of the Environmental Report
  - 1.2 Site History
  - 1.3 Purpose and Need for the Proposed Action
  - 1.4 Regulatory Provisions, Permits, and Required Consultations
- Hermes 2 ER content that is different from Hermes
  - Chapter 1 is an introductory chapter. The content that is present in Hermes 2 Ch. 1 is related to the design and operating characteristic changes described throughout the rest of the Hermes 2 ER.

# ER Chapter 2: Proposed Action

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- Hermes 2 ER Chapter 2 Format
  - 2.1 Proposed Action
  - 2.2 Site Location and Layout
  - 2.3 Non-Power Reactor
  - 2.4 Water Consumption and Treatment
  - 2.5 Cooling and Heat Removal Systems
  - 2.6 Waste Systems
  - 2.7 Storage, Treatment, and Transportation of Radioactive and Nonradioactive Materials
- Hermes 2 ER content that is different from Hermes
  - An increase in workers, materials, coolant and fuel quantities, water consumption, heat removal, waste, and transportation to account for both units, a longer operating lifetime (10 EFPY), and additional systems such as the PGS and the IHTS.
  - The Hermes 2 facility layout, which includes 2 reactor buildings, a turbine building, and a switchyard.

# ER Chapter 3: Description of the Affected Environment

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- Hermes 2 ER Chapter 3 Format
  - 3.1 Regional Climatology
  - 3.2 Water Resources
  - 3.3 Socioeconomics
  - 3.4 Environmental Justice
- Hermes 2 ER content that is different from Hermes
  - Regional Climatology, Socioeconomics, and Environmental Justice include updates from 2 additional years of data
  - Water usage increased to account for a larger facility
- Sections relying entirely on incorporation by reference
  - Land Use, Visual Resources, Air Quality, Noise, Geologic Environment, Ecological Resources, Historic and Cultural Resources, and Human Health were not included, as all information therein is presented in the Hermes ER.

# ER Chapter 4: Impacts of Proposed Construction, Operations, and Decommissioning

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- Hermes 2 ER Chapter 4 Format
  - 4.1 Land Use and Visual Resources
  - 4.2 Air Quality and Noise
  - 4.3 Geologic Environment
  - 4.4 Water Resources
  - 4.5 Ecological Resources
  - 4.6 Historic and Cultural Resources
  - 4.7 Socioeconomics
  - 4.8 Human Health
  - 4.9 Waste Management
  - 4.10 Transportation
  - 4.11 Postulated Events
  - 4.12 Environmental Justice
  - 4.13 Cumulative Effects
- Hermes 2 ER content that is different from Hermes
  - Chapter 4 examines the impacts of the proposed action on the environment. The content that is present in Hermes 2 ER Ch. 4 is introduced in ER Ch. 2, ER Ch. 3, PSAR Ch. 11 (normal effluent analysis), and PSAR Ch. 13 (accident analysis). The impact analyses are presented in Ch. 4.
  - Cumulative Effects include a discussion on the cumulative impacts of the Hermes and Hermes 2 facilities.
- No changes to the determination that all impacts to the environment from the proposed action are SMALL.

# ER Chapter 5: Alternatives

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- Hermes 2 ER Chapter 5 Format
  - 5.1 No-Action Alternative
  - 5.2 Reasonable Alternatives
  - 5.3 Evaluation of Reasonable Alternative Site Discussion
  - 5.4 Cost-Benefit of the Alternatives
  - 5.5 Comparison of the Potential Environmental Impacts
- Hermes 2 ER content that is different from Hermes
  - The business case for the Hermes site is further strengthened by:
    - The close proximity to transmission lines, mitigating environmental impacts from the added power conversion cycle.
    - The ability to share resources and personnel across the facilities on site.



# ER Chapter 6: Conclusions

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- Hermes 2 ER Chapter 6 Format
  - 6.1 Unavoidable Adverse Environmental Impacts
  - 6.2 Relationship between Short-Term Uses and Long-Term Productivity of the Environment
  - 6.3 Irreversible and Irretrievable Commitments of Resources
- Hermes 2 ER content that is different from Hermes
  - The portion of the permanently-disturbed area containing structures is increased to account for additional buildings.
  - Installation of electrical power transmission lines onsite
  - Materials committed to the project are increased as discussed in Chapter 2 and Chapter 4.
- No changes to the determination that all impacts to the environment from the proposed action are SMALL.

# ER Transmission Line Appendix

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- Hermes 2 ER Transmission Line Appendix Format
  - The Transmission Line Appendix analyzes all previously reported sections of the ER and discusses the environmental impacts of the proposed transmission lines on each of those sections.
- Hermes 2 ER content that is different from Hermes
  - The Appendix supplements all other sections of the ER by considering how the proposed transmission lines may impact the affected environment.
  - The construction, operation, and decommissioning of the transmission lines are not expected to alter the impact designation of SMALL for any resource.