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SP-100 Ground Engineering System Requirements and Analysis

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BACKGROUND ON NATIONAL SP-100 EFFORTS

The SP-100 Program is sponsored jointly by the U.S. Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the U.S. Department of Defense (DOD) for the purpose of developing a nuclear reactor power system that can enhance and/or enable future civilian and military space missions. The program is directed to develop space reactor technology to provide electrical power in the range of tens to hundreds of kilowatts.

The DOE is responsible for development and ground testing of hardware usable for future space missions. This responsibility encompasses generic flight system design, ground engineering subsystems design, engineering development, and ground testing to validate the readiness of the system technology for dedicated flight use. The generic flight system is a 100-kW electric space reactor power system point designed by General Electric Company that provides the basis for Ground Engineering System (GES) Test Site activities. This design is adapted as necessary for ground testing.

The major assembly-level nuclear test to be conducted in the SP-100 GES Program is referred to as the Nuclear Assembly Test (NAT). The NAT is designed to validate the performance of the nuclear assembly by up to two years of reactor operation conducted in a vacuum chamber to simulate space conditions within a reactor containment structure. The test article will include the SP-100 reactor, instrumentation and control, primary heat transport loop, and radiation shield subsystems that are prototypical of the technology required for the flight system design.

Design and Safety Approach

The design, testing, and operation of the SP-100 Test Site must comply with the regulations and requirements promulgated in the DOE Orders. The design and safety requirements for test reactors are unclear in the DOE Orders as well as in the U.S. Nuclear Regulatory Commission (NRC) Regulatory Guides. The mandatory environmental safety and health standards are identified in DOE Order 5480.4 as follows:

Mandatory Policy Requirements for New Construction

- IEEE Std 279-1971, *Criteria for Protection Systems for Nuclear Power Generating Stations.*
- ASME Boiler and Pressure Vessel Code, Division 1, 1986 Edition with addenda through 1987, American Society of Mechanical Engineers, New York, New York.
- IEEE Std 308-1980, *Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.*
- IEEE Std 603-1980, *Criteria for Safety Systems for Nuclear Power Generating Stations.*

Non-Mandatory - Good Practice Guidance

- Code of Federal Regulations, Title 10, Part 50, Domestic Licensing of Production and Utilization Facilities.
- Code of Federal Regulations, Title 10, Part 100, Reactor Site Criteria.
- Other IEEE Standards
- ANS Standards.

The above mandatory standards are being applied to the SP-100 NAT design and operation. The non-mandatory standards are implemented in the application of the 10 CFR 50 general (principal) design criteria, which are modified as appropriate for liquid-metal reactor systems. Siting and seismic requirements of 10 CFR 100 are being applied to the design and analysis. Standards of IEEE and ANS, as well as the NRC Regulatory Guides, are utilized to provide guidance to the subsystem designers.

The preliminary safety analysis report (PSAR) was issued in July 1989 and submitted to the DOE for review. The PSAR was developed consistent with the requirements of the NRC Regulatory Guide 1.70, which is the standard format and content for safety analysis reports. The PSAR is being reviewed by the DOE. Current plans are to issue a safety evaluation report (SER) in April 1990. The SER and PSAR will then be submitted to the assistant secretary for nuclear energy for consideration of approval of construction. Current planning is for approval of construction in October 1990.

Safety Analysis

The SP-100 Nuclear Assembly Test will be located within an existing refurbished containment facility on the Hanford Site. The site layout and containment facility are shown in Figure 1.

The SP-100 GES Nuclear Assembly Test is shown schematically in Figure 2. The design of the NAT is unique with a compact, highly enriched core design, high operating temperatures, and a lithium primary system. The design has been evaluated for a spectrum of design-basis and beyond design-basis

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Figure 1. SP-100 Ground Engineering System Preliminary Equipment Arrangement.

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Figure 2 SP-100 Ground Engineering System
Nuclear Assembly Test.

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