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Definitive Design Status of the SP-100 Ground Engineering System Test Site

E. J. Renkey

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Westinghouse
Hanford Company
P.O. Box 1970
Richland, Washington 99352

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DEFINITIVE DESIGN STATUS OF THE SP-100 GROUND ENGINEERING SYSTEM TEST SITE

Edmund J. Ronkey, Jr., Gerald D. Bazinet, Ernest J. Bitten,
Phillip J. Brackenbury, William F. Carlson, John J. Irwin,
Peter A. Edwards (retired), Eric J. Shen, Peter A. Titzler

Westinghouse Hanford Company
Post Office Box 1970
Richland, Washington 99352
(509) 376-7843

INTRODUCTION

The SP-100 reactor will be ground tested at the SP-100 Ground Engineering System (GES) Test Site on the US Department of Energy (DOE) Hanford Site near Richland, Washington. The Conceptual Design of this facility was previously described (Miller et al. 1988). Project direction and the flight system design evolution have resulted in a smaller reactor size and the consequential revision to Test Site features to accommodate the design changes and reduce Test Site costs. The significant design events since the completion of the Conceptual Design are discussed in this paper.

DESIGN CHANGES

Preliminary design of the Test Site for the Nuclear Assembly Test (NAT) of a 100 kWe (2.5 MWt) reactor system is complete, and the baseline cost estimate reflects changes from the Conceptual Design (Miller et al. 1988) developed for a test of a 300 kWe (6.8 MWt) reactor system.

An artist conceptual drawing of the Test Site is shown in Figure 1.

A change in the Test Assembly Primary Heat Transport System (PHTS) design to include a gas gap intermediate heat exchanger (IHX) and the addition of an Auxiliary Cooling System (ACS) has caused significant changes in the Test Site definitive design direction from that presented during the Preliminary Design review.

The gas gap intermediate heat exchanger was determined by General Electric Co. (GE) to be a better technical and cost effective solution than the earlier regenerator/IHX combination. This change affected the design configuration of the Secondary Heat Transport System (SHTS).

The ACS was added to provide a redundant residual heat removal path that is functionally equivalent to that of the Flight System. The Test Site design was revised to remove the residual heat to an ultimate sink.

A near-reactor shield was added by the Test Site to eliminate the need to provide for cooling the structural concrete and the need to provide a reactor cell activated air hold-up system. The location of the near-reactor shield is shown in Figure 2.

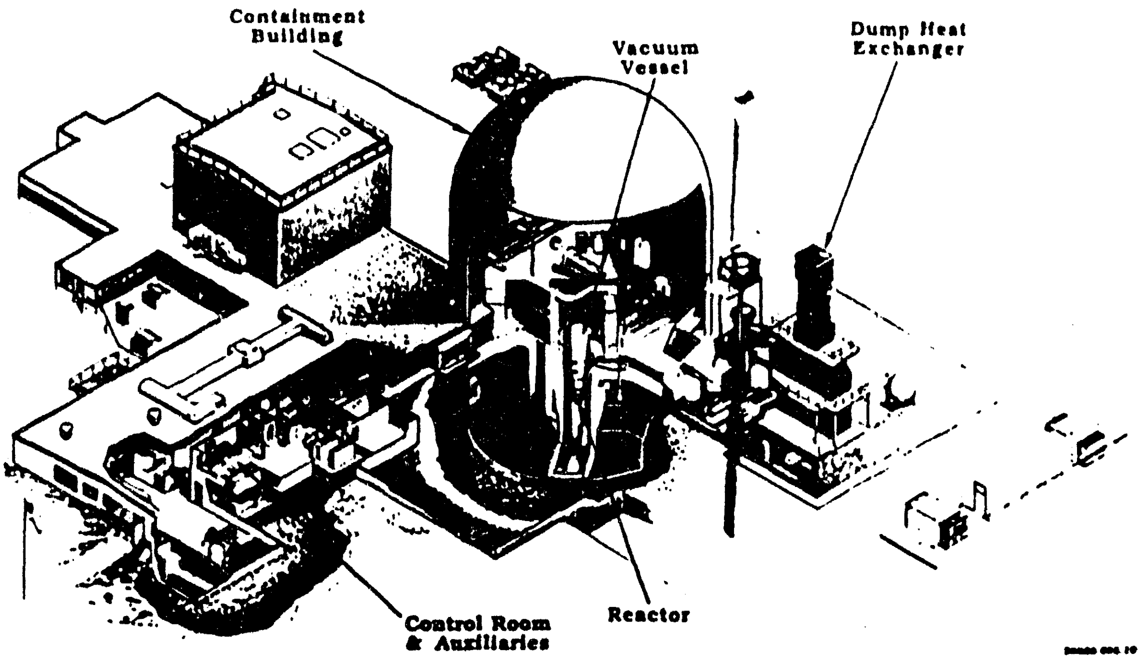

Figure 1 SP-100 GES Test Site

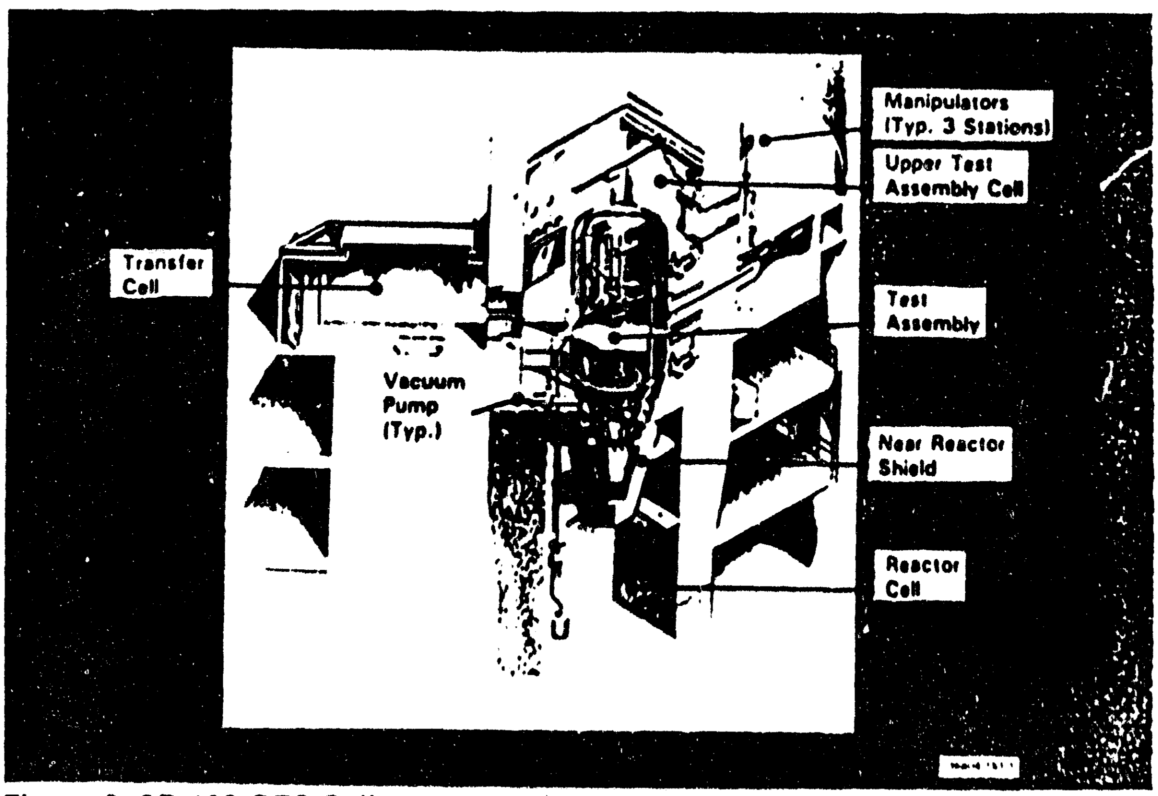

Figure 2 SP-100 GES Cells

ISSUE RESOLUTION

Significant progress has been made toward resolution of the six issues identified during the Test Site conceptual design (Miller et al. 1988).

1. The sodium processing system includes traps to remove nitrogen impurities to very low levels. This is necessary to protect the Nb-1Zr material of the IHX.

2. Design criteria for the allowable oxygen concentration in the Nb-1Zr has been developed jointly by GE, Westinghouse Hanford Company, and Oak Ridge National Laboratory.

3. An ACS was added to the Test Assembly to provide redundant residual heat removal. The Test Site added a secondary cooling system to remove this heat to an ultimate heat sink.

4. Tests are being performed to determine the radiation damage to vacuum system cryo-pumps.

5. The vacuum vessel and system procurement cycle was initiated on time; however, programmatic extensions and the uniqueness of the requirements have delayed the placement of any contract.

6. Several system design reviews have been completed to ensure compliance with project objectives in a cost-effective manner. Budget constraints have been a constant incentive to develop creative engineering solutions at the lowest cost.

NEW ISSUES

The definitive design development has identified two issues that require early resolution to support the design and construction schedule.

1. The redundant residual heat removal systems require safety (1E) power for significant lengths of time. The site may not have sufficient room within the existing structure for the battery capacity required to support the residual heat removal systems. Generators may be required to supply 1E power.

2. The leakage of air into the vacuum vessel while the Test Assembly is at operating temperature will cause the Nb-1Zr material properties to degrade. The safety implications of this leakage may cause the vacuum system to be designed to nuclear safety standards that are not normal in the vacuum industry.

SITE PREPARATION/EQUIPMENT REFURBISHMENT

The ex-containment site preparation activities are complete. These activities included equipment and asbestos removal from the basement of the Control and Service Building, as well as removal of a contaminated shield wall. Excavation in the area of the future Dump Heat Exchanger (DHX) Building included removal of underground piping from the rupture loop annex to the exhaust stack High-

Efficiency Particulate Air (HEPA) filters. A new rupture loop annex HEPA filter and exhaust were completed.

One of the Fast Flux Test Facility (FFTF) Closed Loop System surge tanks (Figure 3) and the associated cover gas valves and piping were removed and placed in controlled storage. A preheater controller panel was also removed and placed in storage. All equipment was refurbished for use at the Test Site.

Tests of the control characteristics of a surplus FFTF DHX were completed to determine its ability to support Test Site simulated space flight operational testing of the SP-100 NAT. The DHX will be moved to the Test Site after its support building is constructed in 1990.

PROCUREMENTS

Several long-lead procurement specifications were prepared for equipment such as the vacuum vessel and vacuum pumping system (Figure 4), containment electrical penetrations, electrical switchgear and transformers, and the facility control system. The containment electrical penetrations were ordered, received, and placed in controlled storage. The facility control system was also ordered.

FACILITY MODIFICATIONS

The first facility modification design package, which includes all site preparation around the 309 Building, construction of the DHX Building, all structural changes to the Control and Service Building, the main electrical power supplies, the water chillers and ex-containment piping, and the air compressors and ex-containment piping, is nearly complete.

CONCLUSIONS

The definitive design of the SP-100 GES Test Site is proceeding at a pace consistent with the GE Test Assembly design and funding profile. Satisfactory progress has been made toward resolution of the key technical issues identified during the conceptual design. Design of the vacuum vessel and vacuum system, along with the placement of equipment within the Test Assembly cell, remain as significant technical challenges.

REFERENCES

Miller, W. C., J. L. Etheridge, P. J. Brackenbury, W. F. Carlson, P. A. Edwards. J. J. Irwin, E. J. Renkey, and E. J. Shen, 1988, "Conceptual Design of the SP-100 GES Test Site," in Space Nuclear Power Systems 1987, V7, M. S. El-Genk and M. D. Hoover, eds, Orbit Book Co., Malabar, Florida.

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Figure 3 FFTF Closed Loop Surge Tank Removal

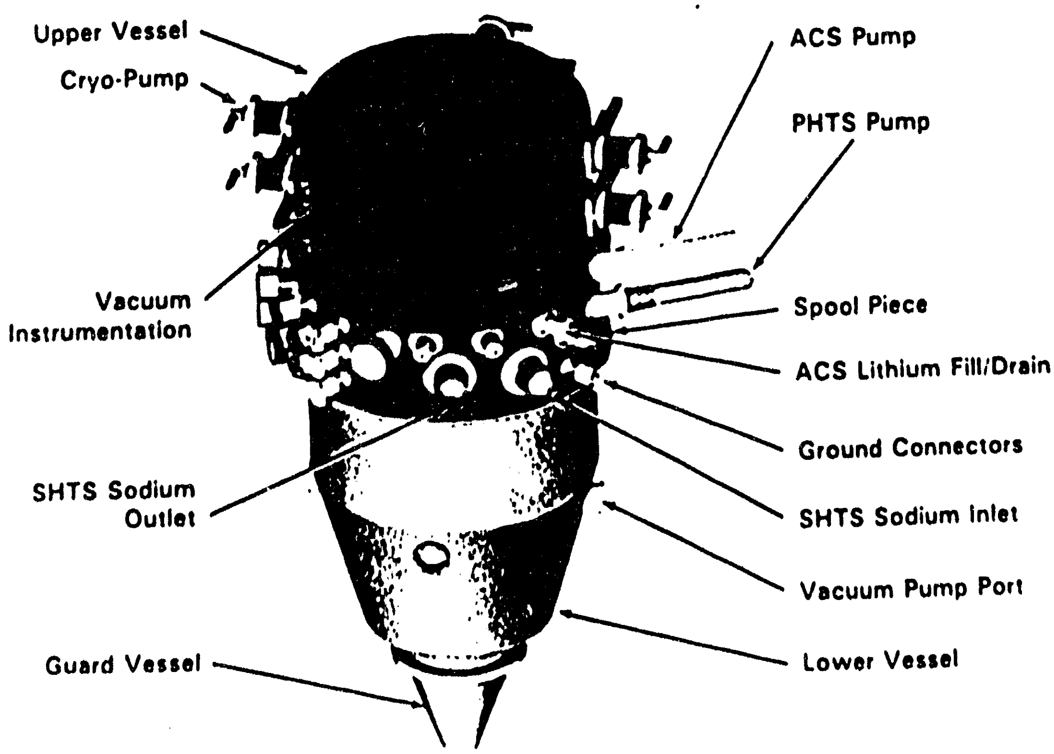

Figure 4 SP-100 GES Vacuum Vessel

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