HFD-42024

HELIUM STORAGE AND TRANSFER SUBSYSTEM DESIGN DESCRIPTION

4 x 350 MWt MODULAR HTGR PLANT

Author/Contractor

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For the Department of Energy

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LIST OF ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
DMS	Data Management System
HEI	Heat Exchange Institute
HI	Hydraulic Institute
HP	High Pressure
HPS	Helium Purification Subsystem
HSTS	Helium Storage and Transfer Subsystem
HTGR	High Temperature Gas-Cooled Reactor
HTS	Heat Transport System
IEEE	Institute of Electrical and Electronics Engineers
ICD	Interface Control Document
LP	Low Pressure
MHTGR	Modular High Temperature Gas-Cooled Reactor
NI	Nuclear Island
NICWB	Nuclear Island Cooling Water Building
NSSS	Nuclear Steam Supply System
OPDS	Overall Plant Design Specification
PPIS	Plant Protection and Instrumentation Subsystem
QA	Quality Assurance
QAL	Quality Assurance Level
OBE	Operating Basis Earthquake
RB	Reactor Building
RAB	Reactor Auxiliary Building
RSB	Reactor Service Building
SDD	System Design Description
SSDD	Subsystem Design Description
SWS	Service Water Subsystem
TBD	To Be Determined

DEFINITIONS

[TBD]

PREFACE

The objectives of the HTGR plant project is to produce safe, economical power. Supporting this objective, four major goals and their associated plant states are identified as follows:

1. Maintain Plant Operation

1.1 Maintain Safe Energy Production

1.2 Maintain Safe Shutdown

1.3 Maintain Safe Refueling

1.4 Maintain Safe Startup/Shutdown

2. Maintain Plant Protection (in the event that plant operation cannot be maintained in the normal operating envelope)

2.1 Protect the capability to maintain safe energy production

2.2 Protect the capability to maintain safe plant shutdown

2.3 Protect the capability to maintain safe plant refueling

2.4 Protect the capability to maintain safe plant startup/shutdown

3. Maintain Control of Radionuclide Release (in the low probability event of failure to maintain plant protection)

3.1 Control radiation

3.2 Control personnel access

4. Maintain Emergency Preparedness (in the extremely low probability of failure to maintain control of release of radionculide).

The Overall Plant Design Specificaion (OPDS) is the top-level technical document for the HTGR plant. The OPDS (based on owner requirements and regulatory requirements) establishes the overall performance, functional, institutional, interface, operational, safety, maintenance, inspection, and decommissioning requirements for design of the plant.

In response to the OPDS, a series of lower tier documents, System Design Descriptions (SDDs), Subsystem Design Descriptions (SSDDs), Buildings and Structures Design Descriptions (BSDD), Component Design Specifications (CDSs), and Interface Control Documents (ICDs), describe and control the individual designs. Traceability of requirement source from plant-level requirements to equipment-level requirements shall be maintained throughout this hierrachy of design documents

SUMMARY

The Helium Storage and Transfer Subsystem (HSTS) consists of two parts. The first consists of nine (9) high pressure storage tanks containing helium at 15.6 MPa (2,250 psig). These tanks provide makeup and purge helium at a rate of 1,216 kg per year (2,680 lb/year) to the various helium users, including circulator bearing seals, analysis packages, and cooling system surge tanks. The second, larger part of the system, provides for the low pressure storage of 6,078 kg (13,400 lb) of primary coolant helium in 180 storage tanks at 7.0 MPa (1,000 psig). The system serves all four (4) reactor modules.

The low pressure storage part of the system receives helium from the discharge of Helium Purification Subsystem (HPS) and is activated during depressurization and pumpup operations only. It is not required to operate continuously. Storage capacity is provided for primary helium coolant from two reactor modules. However, since depressurization and pumpup operations are performed for only one reactor module at a time, two 50 percent capacity low pressure transfer compressors are provided having a total transfer capacity of 340 am^3/h (200 acfm) which is sufficient to service one module. High pressure helium is supplied continuously to all the four reactor modules simultaneously from the high pressure storage tanks. These tanks are replaced periodically with fresh tanks.

SECTION 1

SUBSYSTEM FUNCTIONS AND DESIGN REQUIREMENTS

1.1 Subsystem Functions

The function of the Helium Storage and Transfer Subsystem (HSTS) are to:

1. Transfer and store helium when reactor is depressurized
2. Transfer helium to reactor during startup
3. Supply high pressure helium for various station uses

These functions apply to all states of the Integrated Approach Goal 1 operations as determined by the functional analyses and in conjunction with the Helium Purification System support the plant goals defined in the OPDS (Ref. 1).

1.2 Subsystem Design Requirements

The subsystem design requirements discussed below include subsystem specific requirements and applicable top-level utility and regulatory requirements.

1.2.1 Subsystem Configuration and Essential Features Requirements

The HSTS shall provide for supply of high pressure helium.

(2024.0102.001)*

The HSTS shall be capable of receiving helium from the discharge of HPS during pumpdown (depressurization) operations.

(2024.0102.002)

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* Requirement Traceability Number

[Storage capacity shall be provided for helium coolant inventory of at least two reactor modules.]

(2024.0102.003)

[Crossover connection shall be provided between the high pressure and low pressure systems for reliability of operation.]

(2024.0102.004)

[Reserve storage capacity shall be provided in the high pressure storage part to allow for unforeseen supply cut-off situation.]

(2024.0102.005)

1.2.2 Operational Requirement

The HSTS shall supply high pressure helium continuously to all four reactor modules.

(2024.0102.021)

The HSTS shall provide high pressure helium at a rate of 1,216 kg/year (2,680 lb/year) to various users.

(2024.0102.022)

[The compressors shall be capable of performing both pumpup and pumpdown operations.]

(2024.0102.023)

[The compressors shall be sized to serve at least one reactor module at a time.]

(2024.0102.024)

[Each compressor shall be rated at least 7.0 MPa (1000 psig) discharge pressure.]

(2024.0102.025)

Pumpdown and pumpup operations shall be completed in 20 hours and [5] hours, respectively.

(2024.0102.026)

1.2.3 Structural Requirements

[The design pressure and normal operational capability for the HSTS shall be 15.6 MPa (2,250 psig) for the supply section and 7.0 MPa (1,000 psig) for the storage section.]

(2024.0102.031)

For generic and plant level structural requirements refer to OPDS (Ref. 1).

(2024.0102.032)

1.2.4 Environmental Requirements

[The HSTS shall be designed to perform its functions over a temperature range of 0°C (32°F) to 40°C (104°F) and a relative humidity range of 0 to 95 percent.]

(2024.0102.041)

For generic and plant level environmental requirements refer to OPDS (Ref. 1).

(2024.0102.042)

1.2.5 Instrumentation and Control Requirements

[Primary control of the HSTS shall be from the main control room (MCR).]

(2024.0102.051)

[A mode selector shall be provided to allow manual selection of either the pumpdown, pumpup or normal operation of the HSTS.]

(2024.0102.052)

[Local control of the HSTS system components shall also be accomplished from a local control panel.]

(2024.0102.053)

[Instrumentation and controls shall be provided to detect and alarm various parameters so as to provide the operator an indication of system performance and a timely warning of impending equipment degradation.]

(2024.0102.054)

For generic and plant level I&C requirements refer to OPDS (Ref. 1).

(2024.0102.055)

1.2.6 Surveillance and In-Service Inspection Requirements

This system does not perform a safety-related function and therefore no safety-related surveillance and/or in-service inspection is required. Routine surveillance shall be performed as part of maintenance.

1.2.7 Availability Assurance Requirements

For generic and plant level availability assurance requirements refer to OPDS (Ref. 1).

(2024.0102.071)

1.2.8 Maintenance Requirements

For generic and plant level maintenance requirements refer to OPDS (Ref. 1).

(2024.0102.081)

1.2.9 Safety Requirements

The HSTS is not safety-related. Thus there are no safety requirements.

1.2.10 Codes and Standard Requirements

[The analyses and trade studies for determining the codes and standards and other industry and regulatory requirements which should be applied to the engineering of systems, structures, and components have not yet been performed. However, it is anticipated that those listed on Table 1-1 will be found applicable.]

1.2.11 Quality Assurance Requirements

[TBD]

1.2.12 Construction Requirements

For generic and plant level construction requirements refer to OPDS (Ref. 1).

(2024.0102.121)

1.2.13 Decommissioning Requirements

For generic and plant level decommissioning requirements refer to OPDS (Ref. 1).

(2024.0102.131)

Table 1-1

INDUSTRIAL CODES AND STANDARDS APPLICABLE TO THE HELIUM STORAGE AND TRANSFER SUBSYSTEM

A. ASME Boiler and Pressure Vessel Code, American Society of Mechanical Engineers

1. Section II, Material Specifications
2. Section VIII, Pressure Vessels

B. ANSI Standards, American National Standards Institute

1. ANSI/ASME B31.1, Power Piping

C. ISA Standards, Instrument Society of America

1. ISA-RP12.1, Electrical Instruments in Hazardous Atmospheres, Recommended Practice.
2. ISA-RP25.1, Materials for Instruments in Radiation Service, Recommended Practice.

D. NEMA Standards, National Electrical Manufacturers Association

1. NEMA-ICS 1, General Standards for Industrial Control and Systems.
2. NEMA-ICS 2, Standards for Industrial Control Devices, Controllers, and Assemblies.
3. NEMA MG 1, Motors and Generators
4. NEMA TR 1, Transformers, Regulators, and Reactors.

SECTION 2

DESIGN DESCRIPTION

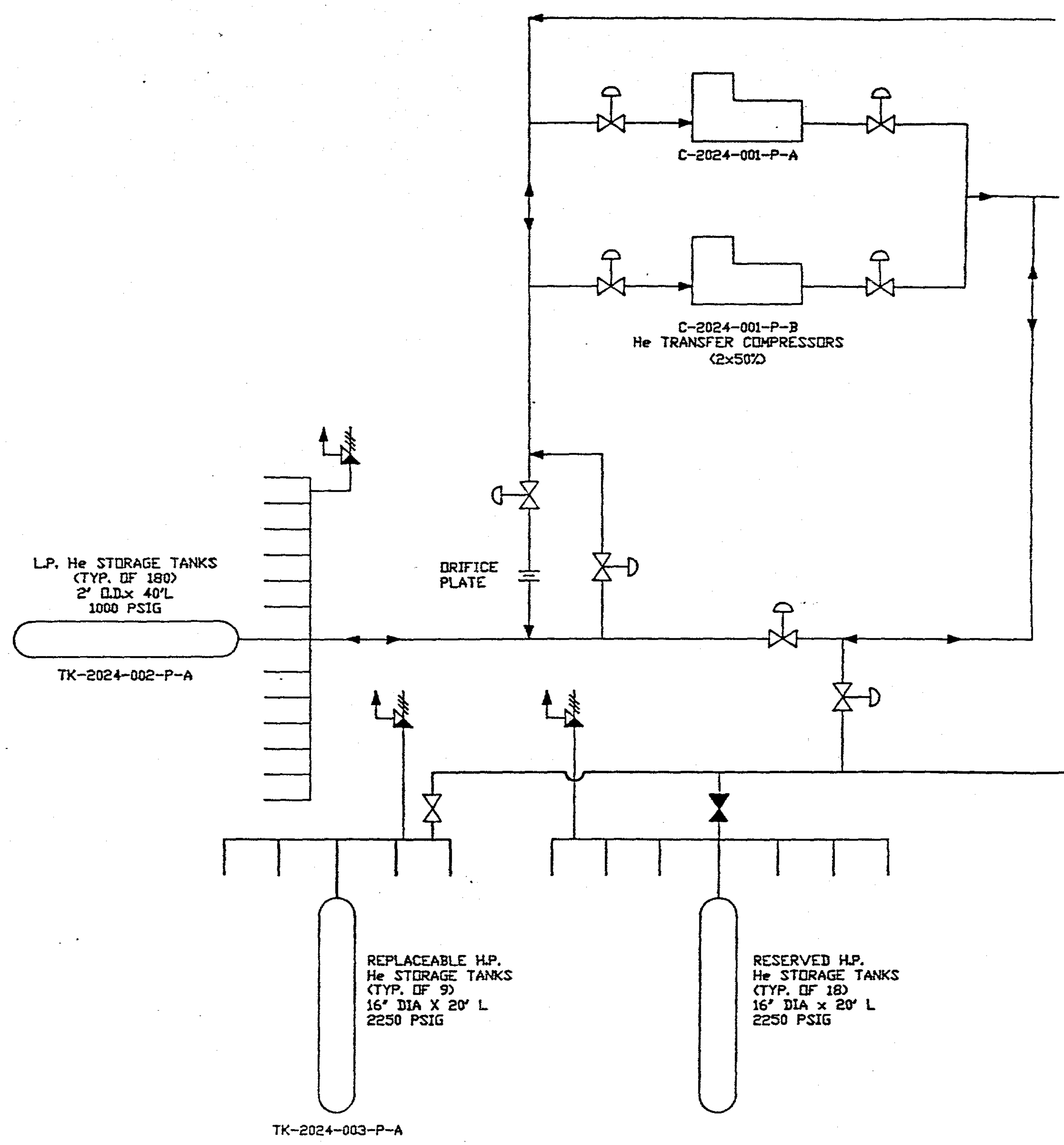
2.1 Summary Description

The Helium Storage and Transfer Subsystem (HSTS) consists of two parts. The first consists of nine (9) high pressure storage tanks containing helium at 15.6 MPa (2,250 psig). These tanks provide makeup and purge helium at a rate of 1,216 kg per year (2,680 lb/year) to the various helium users, including circulator bearing seals, analysis packages, and cooling system surge tanks. The second, larger part of the system, provides for the low pressure storage of 6,078 kg (13,400 lb) of primary coolant helium in 180 storage tanks at 7.0 MPa (1,000 psig). The system serves all four (4) reactor modules.

The low pressure storage part of the system receives helium from the discharge of Helium Purification Subsystem (HPS) and is activated during depressurization and pumpup operations only. It is not required to operate continuously. Storage capacity is provided for primary helium coolant from two reactor modules. However, since depressurization and pumpup operations are performed for only one reactor module at a time, two 50 percent capacity low pressure transfer compressors are provided having a total transfer capacity of 340 am^3/h (200 acfm) which is sufficient to service one module. High pressure helium is supplied continuously to all the four reactor modules simultaneously from the high pressure storage tanks. These tanks are replaced periodically with fresh tanks.

2.2 Subsystem Configuration

The HSTS configuration is shown schematically in Figure 2-1. The high pressure system provides makeup and purge helium for various helium users. The makeup helium is needed to compensate for NSSS leakages, leakage past vessel penetrations (seals), analytical sampling leakages, etc. Typical helium purge requirements include that for the helium purification



OPERATING MODE	NORMAL	PUMP UP	PUMP DOWN
PERFORMANCE	H.P. PART SUPPLIES HELIUM	COMPLETED IN [5] HRS.	COMPLETED IN 20 HRS.

8 7 6 5

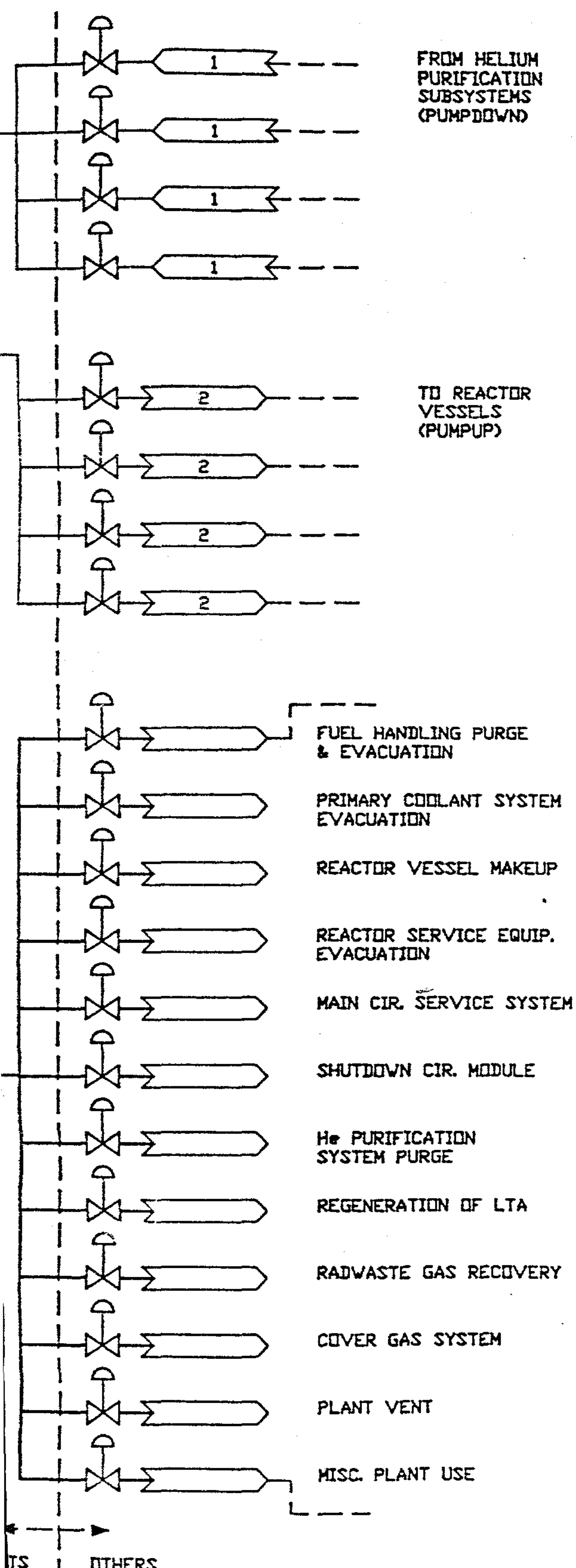


Figure 2-1

0		ISSUED FOR SSDD/SDD	

MLK/ACAD

BECHTEL NATIONAL, INC.
SAN FRANCISCO

GAS-COOLED REACTOR ASSOCIATES
4x350 MW(t) MHTGR

HELIUM STORAGE & TRANSFER
SUBSYSTEM FLOW DIAGRAM

JOB NO.	DRAWING NO.	REV.
14508	M-0500	0

regeneration equipment (dryers and low temperature adsorbers), for the fuel storage facility, etc. The low pressure storage of the reactor coolant inventory accommodates the reactor pumpdown (or depressurization) and pumpup (or repressurization) required during a refueling or maintenance outage.

The high pressure part consists of nine (9) high pressure storage tanks and associated piping, valves, controls, and instrumentation. The storage tanks are 0.4m (16 in.) in diameter and 6.1m (20 ft long). The storage tanks satisfy the makeup and purge needs both when the reactor modules are operating or when depressurized for refueling or maintenance. The storage tanks are replaced once every four weeks when pressure drops to about 7.0 MPa (1000 psig). Eighteen additional tanks are provided in permanent storage as a reserve eight week supply in case the normal replacement service is cut off.

An adequate inventory is maintained in the high pressure storage tanks, and the purge and makeup needs are supplied directly from the storage tanks without the use of any compressor. The helium pressure required at the various points of use ranges from [TBD] to [TBD]. Differences in helium pressure between the storage tanks and the points of use enable the system to operate without any compressor. Properly sized pressure-reducing control stations are used for each point of use. The system is sized so that the purge and makeup needs for all the four reactor modules can be supplied simultaneously.

The low pressure part of the HSTS consists of 180 low pressure storage tanks, two (2) 50 percent capacity transfer compressors, and associated piping, valves, controls and instrumentation. Each compressor is rated at 170 am^3/h (100 acfm) and 7.0 MPa (1000 psig) discharge pressure, and each storage tank is 0.61m (2 ft) in diameter and 12.2m (40 ft) long.

Pumpdown of the primary coolant to the storage tanks is carried out through the Helium Purification Subsystem to reduce radioactive contaminants in helium to acceptable levels prior to leaving the Reactor Building. First, the primary coolant and storage tanks are equalized in pressure, using a flow control orifice which limits the volumetric flow to the storage tanks (to prevent damage to HPS components). Finally, the reactor vessel is pumped down by means of the transfer compressors. Radioactivity levels in the HSTS is low enough such that release of all helium would not result in exceeding onsite or offsite dose limits. Pumpup of the reactor is carried out in a reverse manner, i.e., the storage tanks and reactor vessel are first equalized in pressure (through the pressure reducing stations, not through the Helium Purification Subsystem), and the remaining pumpup is completed with the transfer compressors. Special instrumentation and procedures are used for process control, including those which prevent overfill/overpressurization of the reactor vessel.

The compressors are used to fulfill multiple functions. Both the pumpdown and pumpup operations are performed by the same compressors since the two operations are not required simultaneously. The compressors are sized to serve one reactor module at a time. No standby or backup capacity is provided. If one compressor is inoperative, the other can perform all functions at a slower rate. Moreover, since the compressor functions are not very frequent, the compressors can be maintained in an operable condition through periodic tests and preventive maintenance.

The storage pressure, which is the same as the compressor discharge pressure, is established by the requirement to repressurize the reactor module at somewhat less than the primary coolant operating pressure, 6.6 MPa (925 psig). The storage pressure is also based on the cost considerations of the compressors and the storage tanks (determined by their size and pressure). The storage pressure is thus selected to be 7.0 MPa (1000 psig).

The storage capacity requirements for the four-module complex is selected to be two times the requirement for a single module inventory. A higher storage capacity is not provided because it is unlikely that more than two modules would be down for maintenance or refueling at the same time. If in an unlikely event more than two modules need to be depressurized at the same time, the excess helium may be released through the plant vent via the Helium Purification Subsystem.

Each compressor is powered from an independent 480 V bus. All valves are power-operated diaphram actuated.

2.3 Subsystem Performance Characteristics

2.3.1 Subsystem Operating Modes

2.3.1.1 Normal Operation

In this mode the high pressure part supplies fresh helium continuously during normal reactor operation. The low pressure part remains on standby condition.

2.3.1.2 Pumpup Operation

In this mode, the low pressure part transfers helium from storage to the reactor module during reactor startup operation. The high pressure part continues to supply helium to the operating modules.

2.3.1.3 Pumpdown Operation (Depressurization)

In this mode, the low pressure part depressurizes the reactor module and transfers helium from the module to storage. The high pressure part continues to supply helium to the operating modules.

2.3.2 Subsystem Steady State Performance

The high pressure storage tanks are supplied at 15.6 MPa (2250 psig) from off-site sources (supply trucks/trailers). The storage tanks are supplied prefilled and mounted on a trailer. The trailer is parked and tied down in the Helium Storage Structure. During normal operation, these tanks supply fresh helium to the various high pressure users through pressure-reducing control valves. The total helium requirement is 1516 Kg/year (2,680 lb/year). The storage tanks have a total capacity of 7.07 m^3 (250 cu ft). The tanks are replaced once every four weeks. The pressure in the tanks drops to about 7.0 MPa (1000 psig) between replacements.

The low pressure helium transfer part of the system is inactive during normal power operation. During depressurization of a reactor module for refueling or maintenance operations, the system is activated. The first step in the pumpdown procedure is to open the valve in the pumpdown line that contains the flow restricting orifice. The storage tanks contain helium at 0.31 MPa (30 psig) before the reactor pumpdown starts. After the pressure ratio (reactor vessel to storage) across the orifice drops below critical, the valve in the bypass line is opened to increase the flow. After the pressure in the reactor coolant system and the storage tanks has equalized, the valves in the blowdown line are closed and the remaining helium is pumped into storage at 7.0 MPa (1000 psig) using the compressors. The depressurization procedure is completed in 20 hours.

The first step in the procedure to return the helium inventory to the reactor is to open the valve that allows the pressures in the storage and reactor coolant system to equalize. After pressure equalization, the valve positions are changed to allow the compressors to pump the remainder of the helium into the reactor coolant system. The pumpup procedure is completed in [5] hours.

2.3.3 Subsystem Response to Plant Transients

The AOO's and DBE's defined for the NSSS do not directly relate to the HSTS. However, certain of the initiating events apply to the HSTS, i.e., loss of offsite power, (AOO-1 and DBE-1) and a large earthquake (DBE-5).

Loss of compressors due to loss of power precludes normal pumpdown of reactor to storage. This results only in the delay of routine reactor depressurization until power is restored and has no safety implications.

The HSTS is designed to continue to operate through an OBE (0.15 g ground acceleration). The HSTS is not required to operate through an SSE as assumed for DBE-5.

2.3.4 Subsystem Failure Modes and Effects

The principal failure mode of the HSTS is the failure of one or both compressors. The failure of one compressors will cause the pumpdown operation to function at a slower rate, and it will take approximately [30] hours for complete depressurization of one reactor module (it takes 20 hours when both the compressors are used).

In the unlikely event of failure of both the compressors simultaneously, the depressurization can not be completed until at least one compressor is brought on line.

2.4 Subsystem Arrangement

All the major components of the HSTS are located in the Helium Storage Structure. The structure is located at grade approximately 46m (150 ft) east of the Reactor Building-Reactor Auxiliary Building complex (See Appendix B for drawings).

The two compressors and the high pressure storage tanks occupy one part of the structure, while the low pressure storage tanks occupy the other, larger part of the structure. Each compressor assembly is placed on a separate pad and is skid-mounted. Each compressor is located in a separate enclosure to provide a clean environment and for ease of maintenance.

The storage tanks are assembled in wine-rack-like steel structures. Each rack holds nine storage tanks, three tanks wide by three tanks high. This arrangement makes each rack shippable as a single shop fabricated module. Each rack measures 2.74m x 2.74m x 12.2m (9 ft x 9 ft x 40 ft) long. 20 such racks are used for the low pressure storage. For the high pressure storage, two racks are used for standby storage tanks, and one rack with nine storage tanks is used for normal supply and is replaced once every four weeks.

2.5 Instrumentation and Control

Control of the HSTS is accomplished from the main control room (MCR). A mode selector allows manual selection of either the pumpdown, pumpup, or standby operation of the HSTS. The mode selection aligns the correct valves to allow equalization of pressure between the low pressure (L.P.) storage tanks and the reactor coolant system. During normal plant operations, the mode selector is in the standby position and all HSTS valves in the L.P. storage part are closed.

Each compressor can be individually started or stopped and isolated, and power-operated valves can be opened or closed at the local control panel.

The following automatic control functions are provided:

1. During the pumpup mode, the compressors are started when the pressure in the L.P. helium storage tanks approaches equilibrium with the reactor pressure. The compressors are stopped when the reactor pressure reaches a preset value of approximately 6.6 MPa (925 psig).
2. During the pumpdown mode, the compressors are started when the reactor vessel pressure approaches the pressure in the L.P. storage tanks. The compressors are stopped when the reactor pressure reaches a preset value of approximately 108 kPa (1.0 psig).
3. Mode selection automatically provides proper alignment of the required HSTS valves.

The local panel provides status indication for each compressor and valve, and alarm annunciation for the following process variables:

1. L.P. storage tanks pressure low, measured in the common header.
2. H.P. storage pressure low, measured in the common header.
3. An individual flow high alarm in the helium supply line to each system supplied from the HSTS.

Local indicators are provided for each of the process variables listed above.

The above process variables are multiplexed to provide a digitized common trouble alarm signal transmitted via the data management subsystem (DMS) communication network to the main control room. Local pressure indicators are provided at the L.P. and H.P. storage tanks and at the inlet and discharge of each compressor.

SECTION 3

COMPONENT FUNCTIONS AND DESIGN REQUIREMENTS

[TBD]

SECTION 4

SUBSYSTEM AND COMPONENT INTERFACES

4.1 Subsystem Interface Requirements

Interface requirements, at the subsystem level, are presented below showing the subsystem on which the requirement is imposed, a brief description of the type of interface, and a statement of the requirement and the general location of the interface.

4.1.1 Interface Requirements Imposed on Other Systems

Interfacing System	Nature of Interface	Interface Requirement
AC Power Supply Subsystem	Electrical Power	Supply 130 kW at 480V for each of the low pressure transfer compressors
AC Power Supply Subsystem	Control Power	Supply [TBD] kW for controls and instrumentation
Service Water Subsystem	Cooling Water	Supply 10 gpm water for compressor cooling

4.1.2 Interface Requirements Imposed on Subsystem Within the Systems

[TBD]

4.2 Component Boundary Definition

[TBD]

SECTION 5

SUBSYSTEM CONSTRUCTION

[TBD]

SECTION 6

SUBSYSTEM OPERATION

[TBD]

SECTION 7

SUBSYSTEM MAINTENANCE

(TBD)

SECTION 8

SUBSYSTEM DECOMMISSIONING

[TBD]

SECTION 9

REFERENCES

1. "Overall Plant Design Specification, 4 x 350 MWt Modular HTGR Plant," HTGR-86-004, Issued by GA Technologies, Inc., November 1985. (Draft)

2. "Modular HTGR Plant Design Duty Cycle," GA Technologies, Inc., Document No. 908728/0, February 14, 1986.

3. Helium Purification SDD (by GA Technologies).

APPENDIX A

TRACEABILITY REQUIREMENTS

Traceability Number	Requirement	Source Ref.	Source Section
2024.0102.001	System shall supply high pressure helium	3	
2024.0102.002	System shall receive helium from HPS	3	
2024.0102.003	[Storage capacity provided for two reactor modules]		*
2024.0102.004	[Crossover connection shall be provided]		*
2025.0102.005	[Reserve capacity shall be provided]		*
2024.0102.021	System shall supply helium to all reactor modules	3	
2024.0102.022	H.P. helium shall provided at a prescribed rate	3	
2024.0102.023	[Compressors shall be capable of operation during all plant modes]		*
2024.0102.024	[Compressor shall be sized to serve one reactor module]		*
2024.0102.025	[Each compressor shall be rated for a prescribed discharge pressure]		*
2024.0102.026	Pumpdown and pumpup operations shall be complete in prescribed time	3	
2024.0102.031	[Shall operate between prescribed design pressures]		*
2024.0102.032	Generic and plant level structural requirements	1	
2024.0102.041	[Shall operate between prescribed conditions]		*
2024.0102.042	General and plant level environmental requirements	1	
2024.0102.051	[Primary control from MCR]		*
2024.0102.052	[Mode selector shall be provided to accommodate various system operation]		*

APPENDIX A (cont'd)

Traceability Number	Requirement	Source Ref.	Source Section
2024.0102.053	[Local control from a local control panel]		*
2024.0102.054	[Instrumentation to measure various parameters]		*
2024.0102.055	Generic and plant level 1 & C requirements	1	
2024.0102.071	Generic and plant level availability requirements	1	
2024.0102.081	Generic and plant level maintenance requirements	1	
2024.0102.121	Generic and plant level construction requirement	1	
2024.0102.131	Generic and plant level decommissioning requirements	1	

* At present these requirements are anticipated and will be confirmed by functional analyses.

APPENDIX B

DRAWINGS

Drawings are included as part of Helium Storage Structure Design Description.

APPENDIX C

TRANSIENTS

[TBD]

APPENDIX D

DESIGN BASIS SEISMIC INPUT

[TBD]

APPENDIX E

EQUIPMENT LIST

Equipment Number	Service Description	Rating, Each
C-2024-001-P-A,B	Helium Transfer Compressors	2 x 50% 100 acfm 1000 psig 130kW (175 hp)
TK-2024-002-P-A	Low Pressure Storage Tanks	180 Tanks 2' OD x 40' long 1000 psig
	Reserve High Pressure Storage Tanks	18 Tanks 16" OD x 20' long 2250 psig
TK-2024-003-P-A	High Pressure Storage Tanks	9 Tanks 16" OD x 20' long 2250 psig

APPENDIX F

PARAMETER LIST

Total Inventory of Helium Stored	6,078 kg (13,400 lb)
Storage Pressure	7.0MPa (1,000 psig)
Total Pumpdown Duration	20 hours
Maximum Flow Rate During Pumpdown	9,130 sm^3/h (5,370 scfm)
Total Helium Makeup Ratre	1,216 kg/yr (2,680 lb/year)
Makeup Helium Storage Pressure	15.6MPa (2,250 psig)
Makeup Pressure Requirement at the point of use	[TBD]

APPENDIX G

PROPRIETARY CLAIMS

[TBD]