Enclosure 1
Changes to Hermes 2 PSAR Chapters 3, 5, and 13
(Non-Proprietary)

3.4 SEISMIC DAMAGE

This section discusses the design and design bases of SSCs that are required to maintain function in the event of an earthquake at the facility. The facility is designed such that there is reasonable assurance that a potential design basis earthquake will not preclude the reactor from shutting down and being maintained in a safe shutdown condition. The consequences of a potential design basis earthquake would be within the dose limits defined in Chapter 13 and are therefore bounded by the maximum hypothetical accident analysis presented in Chapter 13. As discussed in Chapter 13, the requirements in 10 CFR 100 are used to define the dose limit commitments for safe performance of the facility in a design basis earthquake.

A graded performance approach outlined in ASCE 43-19, “Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities” (Reference 1), is used to design the safety-related SSCs in the facility to protect against seismic damage from the design basis earthquake. As stated in the introduction of ASCE 43-19, “The intent [of this Standard] is to control the design process such that the performance of the SSC related to safety and environmental protection is acceptable.” Safety-related SSCs designed to this standard provide reasonable assurance that the reactor can be shut down and maintained in a safe condition. The performance gradations in ASCE 43-19 are based on the radiological hazards of the facility and the specific safety functions of the SSC.

SSCs are designated based on their safety classification. The safety-related SSCs are designed to Seismic Design Category (SDC) 3 consistent with ASCE 43-19, because they are required to maintain their safety function in the event of a design basis earthquake with the exception of the IHTS safety-related rupture disks which are seismically designed to local building code (see Note 6 of Table 3.6-1). SSCs that are non-safety related are designed to local building code, the 2012 International Building Code (IBC, Reference 2), which is consistent with NUREG-1537.

Use of a performance-based approach for graded classification of SSCs is consistent with the guidance from NUREG-1537, including IAEA-TECDOC-403 (Reference 4) and IAEA-TECDOC-348 (Reference 7, now effectively superseded by IAEA-TECDOC-1347, Reference 8) referenced therein. That guidance permits the selection of design basis earthquakes and corresponding SSC seismic design criteria based on their relative safety significance. For the facility, the return period associated with design basis ground motion corresponding to ASCE 43-19 SDC-3 is similar to the maximum considered earthquake specified in building codes with 2% probability of exceedance in 50 years, as were considered and approved by NRC for design of other non-power reactor nuclear facilities. Additionally, due to its relatively shorter operating lifetime, the probability of exceeding the design ground motion level over its operating life is less for than other facilities with design basis ground motions with similar return periods.

3.4.1 Seismic Design for Safety-Related SSCs

3.4.1.1 Seismic Design Criteria

The facility is designed to be capable of shutting down and of being maintained in a safe condition or a condition within acceptable limits (see Chapter 13) in the event of a design basis earthquake. Acceptable seismic performance of safety-related SSCs is defined based on the selected ASCE 43-19 limit state, which is informed by the performance limits or functional safety requirements of the SSC. That is, in the event of a design basis earthquake, SSCs are designed to perform their required safety functions that are credited in the postulated event analyses of Chapter 13. Acceptance criteria are a function of the seismic hazard (ground motion intensity), a design factor, and control of SSC capacity. This design approach defines seismic criteria for credited SSCs using gradation based on limiting dose below specified thresholds.

3.6.2 Classification of Structures, Systems, and Components

SSCs are assigned safety, seismic, and quality classifications consistent with their safety functions. These classifications are described below. Table 3.6-1 provides a summary of these classifications for all SSCs.

3.6.2.1 Safety Classification

SSCs have two possible safety classifications: safety-related or non-safety related. An SSC is classified as safety-related if it meets the definition of safety-related from 10 CFR 50.2 (with exceptions as described in Section 1.2.3). For the KP-FHR technology, the definition of safety-related is modified from 10 CFR 50.2, to be:

> Safety-related structures, systems, and components means those structures, systems, and components that are relied upon to remain functional during and following design basis events to assure:
>
> (1) The integrity of the portions of the reactor coolant boundary relied upon to maintain coolant level above the active core;
>
> (2) The capability to shut down the reactor and maintain it in a safe shutdown condition; or
>
> (3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in 10 CFR 50.34(a)(1) or 10 CFR 100.11

Note that for the KP-FHR technology, the definition above reflects a departure from the definitions in 10 CFR 50.2 for light water reactors that include the terminology "integrity of the reactor coolant pressure boundary." As described in Section 1.2.3 and the Regulatory Analysis for the Kairos Power Salt-Cooled, High Temperature Reactor Topical Report (Reference 1), this departure is necessary because the technology associated with the KP-FHR is based on a near atmospheric pressure design and the reactor coolant boundary does not provide a similar pressure related or fission product retention function as light-water reactors for which these definitions were based.

SSCs that do not meet the definition, as modified above, are classified as non-safety related.

3.6.2.2 Seismic Classification

SSCs are designed according to their safety classification. Safety-related SSCs are classified as SDC-3 consistent with ASCE 43-19 (Reference 2) with the exception of the IHTS safety-related rupture disks which are seismically designed to local building code (see Note 6 of Table 3.6-1). Section 3.4 discusses the SDC-3 classification and Section 3.5 discusses requirements for SSCs that are required to maintain their function in the event of a design basis earthquake. All safety-related SSCs are located in the safety-related portion of the Reactor Building, which is discussed in Section 3.5.1.

The credited safety systems designed to function in a postulated event are described in Chapter 13. For a design basis earthquake, the SDC-3 SSCs that are relied upon to perform a specific credited safety function are listed in Table 3.6-1.

Safety-related systems and components are qualified to maintain their safety function during a design basis earthquake, after a design basis earthquake, or both, depending on the function performed. For example, the reactor vessel is required to perform its safety function (i.e., maintain structural integrity) both during and after a design basis earthquake, whereas the decay heat removal system is required to perform its safety function only after the event, and not during. The specific safety function, therefore, is used to define the ASCE 43-19 Limit State that is used to qualify the SDC-3 SSCs.

SSC Name	Safety Classification	Seismic Design	Quality Program	SAR Section	Plant Area
Intermediate Heat Exchanger	Non-safety related	Local Building Code	Not Quality-Related	5.1.1	SR area
Primary Loop Piping System	Non-safety related	Local Building Code	Not Quality-Related	5.1.1	SR area
Primary Loop Thermal Management	Non-safety related	Local Building Code	Not Quality-Related	5.1.1	SR area
Reactor Coolant	Safety-related	N/A	Quality-Related	5.1.1	SR area
Anti-Siphon Feature	Safety-related	SDC-3	Quality-Related	5.1.1	SR area
Intermediate Heat Transport System					
Intermediate Salt Pumps	Non-safety related	Local Building Code	Not Quality Related	5.2	NSR area
Intermediate Piping ~~System~~	Non-safety related	Local Building Code	Not Quality Related	5.2	SR and NSR area
Superheater	Non-safety related	Local Building Code	Not Quality Related	5.2	NSR area
Intermediate Loop Auxiliary Heating Subsystem	Non-safety related	Local Building Code	Not Quality Related	5.2	SR and NSR area
Intermediate Inert Gas Subsystem	Non-safety related	Local Building Code	Not Quality Related	5.2	SR and NSR area
Intermediate Inert Gas Subsystem Rupture Disks	Safety-related	~~SDC-3~~Local Building Code[6]	Quality-Related	5.2	NSR area
Intermediate Coolant Inventory Management Subsystem	Non-safety related	Local Building Code	Not Quality Related	5.2	SR and NSR area

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6. The Intermediate Heat Transport System (IHTS) SSCs are not relied upon to maintain their structural integrity during and following a design basis earthquake (DBE). Postulated failures of IHTS SSCs during a DBE obviate the safety function of the IHTS rupture disks, therefore the IHTS rupture disks are not required to function during a seismic event and are seismically designed to local building codes.

The reactor coolant is maintained at a positive pressure differential with respect to the IHTS during normal operation. If a postulated IHX tube leak were to occur, reactor coolant would be driven into the IHTS to maintain reactor coolant chemistry and physical properties for investment protection.

The primary components of the PHTS are described in the following subsections.

5.1.1.1 Reactor Coolant

The reactor coolant is a chemically stable, molten mixture of fluorine, lithium, and beryllium (Flibe). A description of the reactor coolant material composition, coolant quality requirements, Flibe impurities, and thermophysical properties is provided in the "Reactor Coolant for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor" Topical Report KP-TR-005 (Reference 1). The reactor coolant performs safety functions associated with reactivity control and fission product retention. The composition of the reactor coolant also enables the reactor core to be designed with a negative coolant temperature coefficient of reactivity. This provides a safety benefit supporting reactivity control, low parasitic neutron absorption for effective fuel utilization, and minimal short-term and long-term activation of the coolant for improved operations and maintenance. The reactor coolant also serves as a fission product barrier providing retention of fission products that escape the fuel particle and fuel pebble barriers for fuel in the reactor core. This additional retention capability contributes to the functional containment and enhanced safety. The circulating activity of the reactor coolant is sampled (see Section 9.1.1) to remain within limits established in the technical specifications.

5.1.1.2 Primary Salt Pump

The PSP is a variable speed, cartridge style pump located on the reactor vessel head that controls system flow rate and pressure in the PHTS under normal operation. The PSP circulates the reactor coolant between the reactor core, where the Flibe is heated as it contacts with the fuel, and the IHX where the heat is transferred to the IHTS. PHTS flow rates are varied based on the operating power of the reactor. The design of the PSP operates continuously at full thermal power flow rates and temperatures, as well as at reduced power and flow rates.

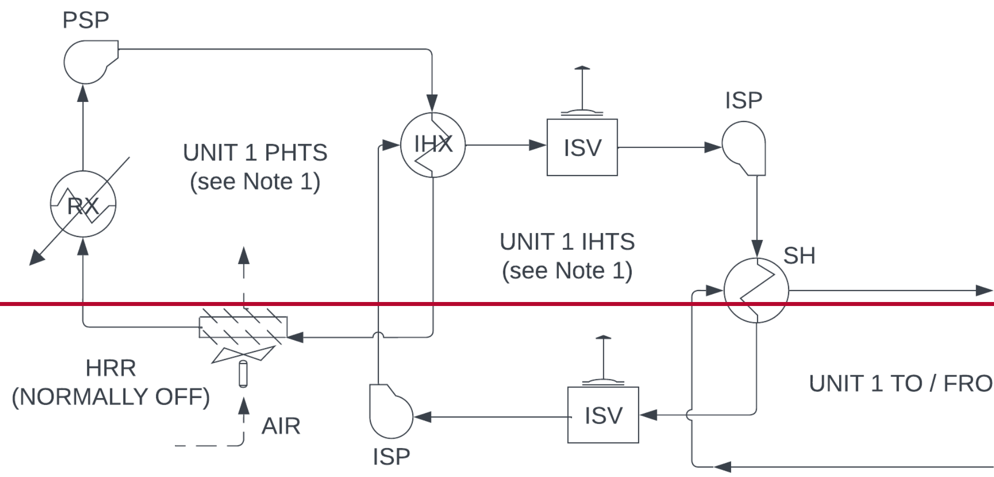
The cantilever pump design extends the shaft down into the reactor coolant while keeping the bearings and seals in a lower temperature region above the coolant. The pump flow discharges horizontally above the reactor vessel head and has a high-point vent that is used for vacuum fill. The pump has a positive pressure inert gas space with a purge gas flow that discharges into the reactor vessel cover gas space. The pump motor rotor is directly mounted on the shaft and operates in the cover gas environment, eliminating the need for conventional shaft seals and providing a hermetic boundary for cover gas. The inert gas system is described in Section 9.1.2.

The design of the pump suction controls and prevents entrainment of cover gas at normal submergence levels. Residual gas in the PHTS at start up is removed by de-entrainment locations in the upper reflector. The pump casing design sets the inlet elevation of the anti-siphon surface for the hot leg when the external PHTS piping is drained and if a leak was to occur in the external portion of the PHTS.

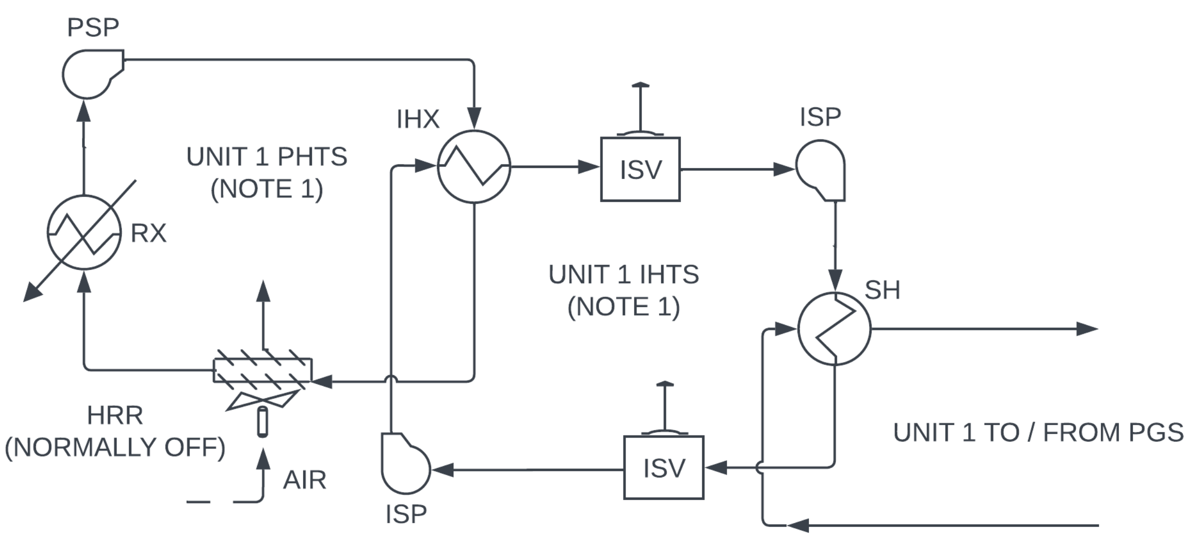
5.1.1.3 Intermediate Heat Exchanger

The IHX serves as the heat transfer interface and coolant boundary between the PHTS and the IHTS. The IHX does not perform any safety-related functions. The reactor coolant is circulated from the PSP outlet nozzle through the primary piping before it enters the shell-side of the IHX, where heat is transferred from the reactor coolant to the intermediate coolant on the IHTS side.

Figure 5.1-1: Primary Heat Transport System and Intermediate Heat Transport System Process Flow Diagram



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



NOTE 1: UNIT 2 PHTS & IHTS ARE SIMILAR

5.2 INTERMEDIATE HEAT TRANSPORT SYSTEM

5.2.1 Description

The Intermediate Heat Transport System (IHTS) transfers heat from the PHTS (Section 5.1) by circulating intermediate coolant between the cooling side of the IHX and the power generation systems (Section 9.9) during normal plant operation. The IHTS includes intermediate salt pumps (ISPs), intermediate salt vessels (ISVs), a superheater, and associated piping. The IHTS transports tritium from the IHX to the tritium management system (TMS) in the cover gas portion of the ISVs. The TMS is described in Section 9.1.3. The IHTS also provides for fill/draining control of the IHTS piping, IHX, and superheater tube side.

The information presented in this section is applicable to both Unit 1 and Unit 2. Each unit has its own IHTS and there are no shared IHTS components between units. A process flow diagram of the IHTS showing both units is provided in Figure 5.1-1. The key design parameters for the IHTS are provided in Table 5.2-1.

The primary system functions of the IHTS are non-safety related and include the following:

- Transport heat from the PHTS to the steam system.
- Manage thermal transients (overall thermal balance) occurring as part of normal operations.
- Maintain intermediate coolant pressure below primary coolant pressure within the IHX.
- Facilitate tritium transfer from the intermediate coolant to the TMS to capture tritium permeating into the IHTS.

There is one safety-related function associated with the IHTS:

- Relieve IHTS pressure in the event of a superheater tube leak or rupture event.

The design of the IHTS allows for on-line monitoring, in-service inspection, maintenance, and coolant replacement activities. The primary components of the IHTS are described in the following subsections.

5.2.1.1 Intermediate Coolant Inventory Management Subsystem

The intermediate coolant inventory management subsystem maintains the total intermediate coolant inventory in the IHTS above a minimum volume and manages the volume of intermediate coolant within the various components of the IHTS. The ISVs within the intermediate coolant inventory management subsystem store surplus intermediate coolant inventory and support system filling and draining during startup and normal shutdown conditions. The ISVs accommodate thermal expansion of the intermediate coolant. Intermediate salt piping inlets and outlets in the ISVs are submerged below the free surface of the intermediate coolant and are physically separated. This feature precludes the transport of vapors entrained in the intermediate coolant across the ISVs.

The intermediate coolant inventory management subsystem includes the functionality to melt new intermediate coolant for addition via the ISVs, and to solidify used intermediate coolant after removal from the ISVs.

5.2.1.2 Intermediate Inert Gas Subsystem

The IHTS design includes an intermediate inert gas subsystem to control intermediate coolant chemistry, to minimize corrosion, and to control and recover tritium. Inert gas within the ISVs is circulated through the TMS to capture tritium in the gas (see Section 9.1.3). Gas composition and impurities within the ISVs inert gas are controlled to maintain conditions which facilitate tritium capture. The intermediate inert gas subsystem is designed to support keeping the intermediate coolant pressure in the heat exchangers lower than the pressure in the PHTS.

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The IHTS is equipped with safety-related rupture disks located in the intermediate inert gas subsystem, in the gas space above the ISVs. The rupture disks preclude a gross failure of the IHX that could occur as a result of a postulated superheater tube leak or rupture event by relieving pressure in the IHTS and providing a relief path for the steam (see Section 13.1.10). The rupture disks are made of ~~austenitic~~ stainless steel 316H~~, which prevents overpressure in the IHTS during a postulated superheater tube leak or rupture event.~~. The maximum temperature of the rupture disk during normal operations is expected to be less than the maximum IHTS hot leg temperature (see Table 5.2-1).

The IHTS rupture disks are designed in accordance with ASME BPVC Section VIII Division 2 (Reference 1). As shown in Table 3.6-2, other safety-related fluid systems are designed ASME BPVC Section III Division 5. The intended scope of ASME BPVC Section VIII Division 2 is more appropriate to the application of the IHTS safety-related rupture disks than Section III Division 5 due to the absence of both a high radiation environment and the need to maintain a safety-related pressure boundary. Further, the rupture disks are providing pressure relief for the IHTS, which is designed in accordance with ASME BPVC Section VIII Division 2. Therefore, ASME BPVC Section VIII Division 2 is the appropriate design code for the IHTS rupture disks.

~~5.2.1.1~~5.2.1.3 Intermediate Coolant

The intermediate coolant is a eutectic mixture of sodium fluoride and beryllium fluoride (57mol%NaF-43mol%BeF_2, referred to as "BeNaF"). BeNaF has similar characteristics to Flibe in that it is thermodynamically stable, is compatible with structural materials, and has analogous chemical properties to the primary Flibe coolant.

5.2.1.4 Intermediate Coolant Chemistry Control Subsystem

The intermediate coolant chemistry control subsystem supports monitoring and control of intermediate coolant chemistry. The intermediate coolant inventory management subsystem may be used to remove and replace a sufficient amount of intermediate coolant to control intermediate coolant chemistry.

5.2.1.5 Intermediate Salt Pumps

The ISPs provide the motive force for the circulation of intermediate coolant between the IHX and the superheater and provide the needed pressure and flow rate in the IHTS. The intermediate coolant is circulated through the superheater where heat is transferred to saturated steam to produce superheated steam in the power generation systems (see Section 9.9).

~~The IHTS is equipped with safety-related rupture disks located in the intermediate inert gas system, made of austenitic stainless steel, which prevents overpressure in the IHTS during a postulated superheater tube leak or rupture event.~~

5.2.1.6 Intermediate Piping

The intermediate piping serves as the flow conduit within the IHTS. The design of the piping accommodates continuous operation at full thermal power and operates under partial load conditions at reduced flow rate.

The design of the IHTS piping includes provisions for filling, draining, and high point venting, and accommodates thermal expansion between the ISPs, the ISVs, and the superheater.

5.2.1.7 Intermediate Loop Auxiliary Heating Subsystem

The IHTS contains an auxiliary heating subsystem to provide non-nuclear heating as needed for plant startup, shutdown, and supplemental heating during normal operation. The auxiliary heating maintains

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the IHTS piping at or above the trace heating setpoint temperature. The source of the heat depends on the subsystem or component requiring the heat. The selected heat source will be described in the application for an Operating License.

5.2.1.8 Superheater

The superheater serves as the heat transfer interface and coolant boundary between the IHTS and the power generation system (PGS; see Section 9.9). The superheater does not perform any safety-related functions. The intermediate coolant is circulated from the ISP outlet nozzle through the intermediate piping before it enters the tube-side of the superheater, where heat is transferred from the intermediate coolant to the steam on the PGS side.

The intermediate coolant enters the superheater at approximately 560-600°C and leaves the superheater at approximately 510°C during normal, steady-state operation at full power.

5.2.2 Design Basis

Consistent with PDC 2, the safety-related SSCs located near the IHTS are protected from the adverse effects of postulated IHTS failures during a design basis earthquake.

Consistent with PDC 60, the IHTS includes features that support the control of radioactive materials during normal reactor operation.

Consistent with PDC 64, the IHTS is designed to monitor radioactive releases.

Consistent with PDC 73, the IHTS includes a passive barrier (IHX) for the reactor coolant system that is chemically compatible with the IHTS coolant and IHTS features that support the control of radioactive materials during normal reactor operation. The IHTS provides two passive barriers (IHX and superheater) between Flibe in the PHTS and steam in the steam system.

Consistent with 10 CFR 20.1406, the IHTS is designed, to the extent practicable, to minimize contamination of the facility and the environment, and to facilitate eventual decommissioning.

5.2.3 System Evaluation

The design of the IHTS is such that a failure of components of the IHTS does not affect the performance of safety-related SSCs due to a design basis earthquake. Those safety-related SSCs will be protected from seismically induced failures of the IHTS by either seismically mounting the applicable components, confirming sufficient physical separation, or by the erection of barriers to preclude adverse interactions. Also, the IHTS is located in safety-related and non-safety related portions of the Reactor Building. As a result, portions of the IHTS may cross the isolation moat discussed in Section 3.5. SSCs that cross the base isolation moat may experience differential displacements as a result of seismic events. The IHTS is designed so that postulated failures of SSCs in the system from differential displacements do not preclude safety-related SSCs from performing their safety function. Design features addressing differential displacement are discussed in Section 3.5. This satisfies the requirements of PDC 2 for the IHTS.

Tritium will be present in the intermediate coolant as part of normal operations of the plant. Control measures will be taken to minimize the release of radioactive material and ensure that it is also below allowable limits. Tritium which permeates through the IHX heat transfer surface is expected to enter the intermediate coolant in the chemical form of HT or T_2. As described in Section 9.1.3, anhydrous hydrogen fluoride will be added to the intermediate inert gas system to convert the tritium to a tritium fluoride that will move into the gas space of the ISVs. The TMS will capture tritium from the gas mixture. Removal of tritium from the ISV gas spaces reduces tritium inventory that is available for release, as

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described in Section 9.1.3. Postulated failures of the IHTS could cause intermediate coolant or cover gas to leak into the reactor building. Such events are evaluated in Section 13.1. These features demonstrate conformance with the requirements in PDC 60.

Radiation monitoring is provided in the ISV cover gas space for the evaluation of radioactivity levels in the gas. This monitoring supports the evaluation of the radioactive material releases that might occur as a result of a system failure. This design feature, in part, satisfies PDC 64.

The IHTS coolant has the potential to be contaminated with Flibe due to a postulated leak of the IHX, as the Flibe is maintained at a higher pressure than the intermediate coolant. However, the two fluids are chemically compatible. Flibe is separated from the water in the power generation system by two passive barriers, the IHX and superheater boundaries. The IHTS is provided with safety-related rupture disks to mitigate the effects of a postulated superheater tube leak or tube rupture event. The rupture disks are sized to relieve pressure in a postulated superheater tube leak or tube rupture event ensuring that pressures in the ISVs, the IHX, and the piping connecting these subsystems do not exceed allowable pressure limits. Additionally, the rupture disks, along with the ISV design, allow a relief path for the steam from a superheater tube rupture and prevent the steam from entering the piping connecting the ISVs to the IHX. These features demonstrate conformance with the requirements in PDC 73.

The IHTS piping is designed to the ASME B31.3 Code (Reference 2). The superheater is designed to ASME BPVC Section VIII. The ISVs are designed to ASME BPVC Section VIII. The IHTS coolant has the potential to be contaminated with tritium or other radioactive materials in a postulated leak from the PHTS into the IHTS, via the IHX. As such, the IHTS includes features that support monitoring radioactive material releases from breaks and leaks in the piping system or via pressure relief equipment. Therefore, the design of the system minimizes contamination and supports eventual decommissioning, consistent with the requirements of 10 CFR 20.1406, as described in Chapter 11.

5.2.4 Testing and Inspection

Descriptions of any tests and inspections of the IHTS will be provided with the application for the Operating License.

5.2.5 References

1. ASME, Boiler and Pressure Vessel Code, Section VIII, Divisions 1 and 2, “Rules for Construction of Pressure Vessels,” New York, NY. July 2017.
2. American Society of Mechanical Engineers, "Process Piping," ASME B31.3. 2018.

~~None~~

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- Shaft fracture
- Bearing failure
- Pump control system errors
- Supply breaker spurious opening
- Loss of net-positive suction head (e.g., pump overspeed, low level)
- Loss of normal electrical power
- Flibe freezing inside HRR
- Loss of normal heat sink (e.g., turbine trip, ISP failure, superheater tube rupture)

During a postulated superheater tube rupture, safety-related pressure relief devices on the IHTS depressurize the system and provide a relief path for steam from the superheater. As described in Section 5.2, the pressure relief devices are located on intermediate salt vessels, and the orientation of the intermediate salt vessel inlet and outlet prevent the steam from a superheater tube rupture from entering the piping connecting the ISVs to the IHX. Liquid water does not accumulate in the IHTS during this event due to the elevated temperatures of the intermediate salt and the depressurization of steam as it moves from the superheater into the IHTS. Therefore liquid water and steam are both prevented from entering the IHX and its connecting piping during this event.

The following sections describe the key assumptions associated with the limiting loss of forced circulation. The quantitative values associated with these assumptions, as well as the methods used to evaluate the surrogate figures of merit that ensure the event consequences are bounded by the MHA are provided in Reference 2.

13.1.4.1 Initial Conditions Assumptions

Normal operating parameters are provided in Section 4.1. Conservative initial values are assumed for each operating parameter to ensure a bounding result for the figures of merit that demonstrate the event is bounded by the MHA.

The loss of forced circulation event initiator is assumed to be a pump seizure, which disables the PSP.

13.1.4.2 Structures Systems and Components Mitigation Assumptions

This section describes the SSCs performing a function to mitigate the consequences of the event.

The RPS is credited with initiating a reactor trip. The PHSS is tripped to prevent damage to fuel in transit. The DHRS is operating when the reactor is above a threshold power, as discussed in Section 6.3, and remains in an “always on” mode. The RPS initiates a reactor trip to shut down the reactor and limits the addition of heat to the system. The PHSS trip stops pebble extraction and insertion following the reactor trip to preclude any damage to pebbles from faults during the event. The DHRS remains active to ensure that an adequate amount of decay heat is removed from the system. The design bases of the RPS are discussed in Section 7.3. The RPS detection and actuation capabilities are automatic and do not rely on manual operator action to perform these functions.

The shutdown elements in the RCSS are credited with shutting down the reactor upon receiving the reactor trip signal. The shutdown elements are assumed to have sufficient worth to shut down the reactor and maintain long term shutdown. The design bases of the RCSS shutdown function are provided in Section 4.2.2.

The DHRS and natural circulation within the reactor vessel are credited with removing an adequate amount of decay heat from the reactor to ensure that material design temperatures are not exceeded and no incremental fuel failures occur due to elevated temperatures. The DHRS does not rely on electrical power or manual operator actions to operate. Natural circulation within the core transfers heat from the fuel to the reactor vessel shell. Energy is transferred from the vessel shell to the DHRS, locations that have design features such as steel liners to prevent BeNaF-concrete interactions. As described in Section 13.1.9, turbine blade missiles could be generated due to a postulated turbine failure. However, those missiles will not affect safety-related SSCs to the extent that they could not perform their safety function due to the favorable orientation of the turbine. Piping associated with the steam and condensate and feedwater systems is routed such that postulated failures do not adversely affect safety-related SSCs.

The failure of safety functions due to internal or external hazards is excluded from the design basis. The reactor building design features, including flood prevention, are described in Section 3.5. The fire protection system is described in Section 9.4. The power generation systems are described in Section 9.9.

13.1.10.11 IHX Gross Failure Due to Superheater Tube Rupture or Leak

A superheater tube rupture could lead to over-pressurization of the intermediate heat transport system. The safety-related pressure relief feature on the IHTS ~~precludes~~ relieves pressure in the IHTS and provides a relief path for the steam. This feature prevents significant Flibe-water interaction in the PHTS that could result from a gross failure of the IHX due to steam over-pressurization. The pressure relief feature is located outside of the safety-related portion of the reactor building to prevent adverse effects on safety-related SSCs. The design of the IHTS is described in Section 5.2.

Operational controls are expected to ensure postulated leaks in the superheater do not lead to corrosion of the IHX beyond an allowable amount. Superheater leaks are expected to be limited by technical specification, as discussed in Chapter 14.