

Enclosure 2
Supplemental Information on Rupture Disk Design Code Evaluation
(Non-Proprietary)

As part of the NRC general audit of the Hermes 2 PSAR, the NRC staff asked for additional information to support the following text in Hermes 2 PSAR Chapter 5:

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.

In support of the PSAR text referenced above, Kairos Power performed a qualitative comparison of the rules of construction codes ASME Section III Division 5 and ASME Section VIII Division 2 to evaluate the differences and conclude that a rupture disk that meets Section VIII requirements will perform as reliably as one conforming to Section III. Some conclusions from the evaluation are provided below.

Roles and Responsibilities

The evaluation concluded that the Section III and Section VIII Codes both ensure that:

1. A design specification is developed that ensures all applicable environmental, damage criteria and operating conditions are listed,
2. Designer / Engineer develops design calculations, drawings, and reports to ensure compliance with the code rules and the design specification,
3. Manufacturer constructs the vessel or part in accordance with the code rules and under a quality assurance program that has been accepted by the authority having jurisdiction.
(Note: Hermes 2 shall be constructed under a quality assurance program in accordance with ANS 15.8-1995 code.)

Due to the similarity in the roles and responsibilities requirements in Section III and Section VIII, the rupture disk constructed in accordance with Section VIII would be of sufficient quality.

Design Specifications

The evaluation concluded that there are no substantive differences in the code requirements for design specifications. The design conditions to be evaluated for the intermediate salt vessel (ISV) design, which will be designed in accordance with Section VIII, include:

- coincident design temperatures and pressures, operating temperatures, and pressures
- fluid transient and flow effects, thermal gradients across vessel sections, if applicable
- cyclic operating conditions, fatigue life analyses
- corrosion effects
- external effects such as nozzle loading and boundary conditions

There is no substantive difference in the manner design specifications are developed in the two codes addressing consideration of operational conditions, environmental conditions, selection of

fabrication processes, inspection requirements during fabrication, testing and changes in material properties due to chemical and physical interaction such as, corrosion, adverse effect on material strength, fatigue, and creep strength due to high temperature. Therefore, the design of ISV rupture disk under Section VIII would provide similar assurance of quality as Section III design requirements.

Overpressure Protection Scope

The evaluation concluded that there is no substantive difference between the scope of overpressure protection required by Section III and Section VIII. Both require consideration of consequences of conditions of coincident pressures and temperatures that cause limits to exceed. Therefore, Section VIII requirements on overprotection scope are sufficient to ensure adequate overprotection scope considering coincident pressure and temperature setpoints.

Overprotection Protection Report

The evaluation concluded that there is no requirement in Section VIII for an overprotection report. However, the relieving capacity required to ensure components remain within their design limits is a part of the design specification of the intermediate heat transport system (IHTS) and will be defined in supporting design documentation.

The design of the IHTS will demonstrate that the IHTS components are maintained within their allowable design limits.

The ISV shall be designed and fabricated to Section VIII and therefore, the manufacturer's Design Report will provide complete details, calculations, drawings, fabrication processes utilized and conformance to the user's design specification as well as code rules of Section VIII. A Certified Manufacturer's Design Report will be generated as part of the fabrication of the ISV.

A certified User's Design Specification shall also be developed as part of the design requirements of the ISV. The design requirements for the ISV will be guided by the design documentation that considers the HCB-7200 requirements as they pertain to the rupture disk.

There will, however, be no overpressure protection report generated as the IHTS is a non-safety related system. A certificate of conformance under UD-1 form will be filed providing the data associated with the rupture disk.

Although, Section III requires an overpressure protection report, the report itself does not add design activities that are not already considered as part of the normal design process for rupture disks that conform to Section VIII. A Section VIII pressure vessel jurisdiction ends at the vessel interface such as a nozzle, it usually operates as an integral part of a system. The system design specifications and requirements define the design specification of the vessel. The ISV vessel design requirements are a consequence of the system design specification for IHTS system design specification and include consideration of the system operating parameters, abnormal operational conditions, transient conditions, equipment malfunction, blockage of pipe, pressure drop in pipes and fitting, and loss of pump and much more. The items delineated in HCB-7220(a-p) will be considered in the design of the IHTS rupture disks, as required by Section VIII.

Therefore, the lack of an overpressure protection report design reporting requirement in Section VIII does not have a substantive effect on the design activities for the rupture disks, supporting the conclusion that Section VIII is sufficient for rupture disk design.

Set Pressure and relieving Capacity

The evaluation concluded that burst pressure tolerances in both Section III and Section VIII code are the same.

The tolerance on total relieving capacity of the overpressure protection device is the same in both codes. However, there is a difference in the terminology between the two codes. In Section III, relieving capacity of an overpressure protection device is based on Design Pressure of the component whereas, in Section VIII it is the Maximum Allowable Working Pressure (MAWP) of the pressure vessel. Since the MAWP of a pressure vessel designed in accordance with Section VIII can be higher than its Design Pressure, the Design Specification will set the MAWP such that the ISV overpressure protection device shall not only protect the vessel from rise in pressure, but will also satisfy the safety-related function during a postulated event.

There are no substantive differences between the Section III and Section VIII set pressure and relieving capacity requirements. For multiple devices, if used, the Section VIII code allows for a 16% (or 4 psi) rise in pressure over MAWP, whichever is greater, while the Section III code allows for 10% (or 3 psi) rise in pressure over the design pressure, whichever is greater. The IHTS is a low-pressure system and therefore, this difference in pressure rise allowed between the two codes is negligible.

Furthermore, it can be addressed in detailed design that, if multiple devices are utilized, the pressure rise is limited to 10% as long as safe and reliable operation of the devices can be assured. Therefore, Section VIII set pressure and relieving capacity requirements are sufficient for setting adequate pressure and relieving capacity of the rupture disks. The design specifications for the rupture disks will address all relevant factors.

Marking of Burst Pressure

The evaluation concluded that marking requirements of burst pressures in both Section III and Section VIII are identical and therefore, a Section VIII rupture disk provides the same quality of construction and conveys sufficient information as Section III.

Production Testing by Manufacturer

The evaluation concluded that there is no substantive difference in the production testing of rupture disks by manufacturer in Section III and Section VIII codes. Therefore, the Section VIII requirements for manufacturing testing are sufficient to ensure the rupture disks have been adequately tested to provide assurance they will perform their safety function.

Tested Capacity

The evaluation concluded that the testing capacity requirements are similar between the two codes. If the set pressure of the ISV falls between 3 psi (20 kPa) and 15 psi (100 kPa), then capacity calculation guidance in accordance with Section III will be utilized.

In conclusion, the technical specifications on capacity tests and certification requirements are substantially similar between Section III and Section VIII, and a rupture disk that conforms to Section VIII has similar assurance of relieving capacity as a Section III rupture disk.

Certification

The evaluation concluded that certification requirements in accordance with Section VIII are sufficient to ensure quality design and construction similar to Section III.