during the transient; peak vessel and core barrel temperatures are key figure of merit to ensure the reactor vessel performs its safety function.

The figures of merit used for systems code analysis (KP-SAM) are a surrogate for demonstrating that consequences are bounded by MHA doses, or for maintaining a coolable geometry. However, if dose is the figure of merit for an event (i.e., a dose analysis is performed for the event), then those surrogate figures of merit for dose do not need to meet acceptance criteria, because the dose acceptance criterion is being explicitly evaluated. Likewise, when a figure of merit has been analyzed separately for bounding conditions (e.g., a structural analysis of the vessel is performed separately from the systems analysis) then that figure of merit does not need to be analyzed in the systems code to meet an acceptance criterion.

The figures of merit ~~derived for each postulated event~~ and ~~the~~ associated acceptance criteria are provided in Table 3-2. The applicable event(s) are those that are expected to provide the limiting case for a given figure of merit.

3.4.2.1 Peak TRISO Temperature-Time

The release pathway for fuel is diffusional release as a function of temperature. During a postulated event, peak TRISO temperature is bounded by temperature-time curve derived from the assumed MHA fuel temperature-time curve to limit diffusion of radionuclides to less than the amount during the MHA. Bounding temperature-time curve derived from the assumed MHA temperature-time curve can be based on integrated effects on dose.

3.4.2.2 TRISO Failure Probability

Based on TRISO fuel qualification efforts as described in (Reference 26), it is expected that during a postulated event, incremental failure of TRISO fuel is limited to a negligible level if the peak temperature is below 1600°C. Failure probability of TRISO fuel can increase due to overpressure in the TRISO particles, which is a function temperature. The failure probability of TRISO fuel is evaluated using the methodology described in Section 4.2.

3.4.2.3 Peak Flibe-cover gas interfacial temperatures

Radionuclide release from Flibe is through evaporation. During a postulated event, peak Flibe-cover gas interfacial temperature is bounded by temperature-time curve derived from the assumed MHA Flibe-cover gas interfacial temperature-time curve to limit evaporation mass transfer of radionuclides to less than the amount during the MHA. Bounding temperature-time curve derived from the assumed MHA temperature-time curve can be based on integrated effects on dose.

3.4.2.4 Peak vessel and core barrel temperature

To prevent vessel failure and maintain long term cooling during a postulated event, the peak vessel and core barrel temperatures must be less than both (a) a maximum allowable temperature derived to limit excessive creep deformation and damage accumulation and (b) 750°C. The maximum allowable temperature is calculated so that the creep strain induced by primary membrane stresses within the vessel and the core barrel does not exceed 1% at the end of reactor life. Its derivation relies on the following assumptions:

- All regions of the vessel and core barrel in contact with Flibe are exposed to temperatures lower than or equal to 650°C for the hot operating time of the vessel and temperatures lower than or equal to the vessel and core barrel peak temperatures for a maximum duration of 360 hours (15 days).

- The maximum primary stresses undergone by the vessel and core barrel can be bounded by a maximum stress value derived as described in the evaluation model for structural integrity.

3.4.2.5 Minimum reactor vessel inner surface temperature

To ensure that the Flibe temperature within the vessel remains above the Flibe freezing temperature ~~during the mission time of the DHRS~~for at least 72 hours, a lower limit on the reactor vessel inner surface temperature is conservatively set to the Flibe freezing temperature.

3.4.2.6 Airborne release fraction of spilled/splashed Flibe

During a salt spill event, aerosols can be generated through jet breakup, and spilling and splashing. The airborne release fractions due to aerosolization must be limited so that the dose consequences of the salt spill events are bounded by the MHA.

3.4.2.7 Volatile products from Flibe chemical reactions

Flibe could be exposed to air during a salt spill event. The key release pathway of radionuclide from Flibe is through evaporation, which is a function of vapor pressure of the radionuclide species. When Flibe is exposed to air, the Flibe-air chemical reaction does not result in excessive reactive vaporization which would form radionuclide chemical species that have a higher vapor pressure than those already exists in Flibe circulating activity. It is expected that a few specific RN chemical species will have a higher vapor pressure after reacting with air than those in the circulating activity. However, those species are expected to be present at very low concentrations and the resulting difference in evaporation rate will be of minimal significance. For example, CsF dissolved in Flibe does not react with air to form a highly volatile cesium hydroxide. As such, Flibe-air reaction does not result in significant additional release of radionuclides from Flibe through evaporation.

The reactor cell floor is assumed to be designed to preclude Flibe-concrete reaction. When Flibe is spilled, it has the potential to come in contact with stainless steel and insulation material. Flibe interactions with stainless steel and insulation do not result in formation of radionuclide chemical species that have a higher vapor pressure than those already exists in Flibe circulating activity. Therefore, Flibe-stainless steel and Flibe-insulation reactions in the Hermes design basis do not result in additional release of radionuclides from Flibe through evaporation.

During a salt spill event, Flibe is not exposed to water, and therefore no Flibe-water reaction need to be considered. However, if a common cause failure (e.g., seismic) causes a water-containing SSC and Flibe-containing SSC to fail concurrently, the amount of water that Flibe could be exposed to is assumed to be limited to an upper bound limit by design. When interacting with this upper bound amount of water, Flibe redox potential is still maintained within the bounds of salt chemistry conditions defined for the evaporation model; therefore, does not result in additional release of radionuclides from Flibe through evaporation.

3.4.2.8 Mass loss of structural graphite and pebble carbon matrix

Pebbles and structural graphite not submerged in Flibe can oxidize when exposed to air. If the mass loss of the pebble carbon matrix does not extend to the fueled zone, tritium release is the only additional MAR release pathway to be considered when fuel pebble oxidizes. Tritium is puff released from oxidized pebble carbon matrix and oxidized structural graphite. In the MHA analysis, the assumed temperature

Table 3-2: Derived Figures of Merit and Acceptance Criteria for Postulated Events

Figure of Merit	Acceptance Criterion	Applicable Events
Peak TRISO temperature-time	Generally bounded by temperature-time curves derived from the assumed MHA fuel temperature-time curve	Salt Spills, Reactivity Insertion, Increase in Heat Removal, Loss of Forced Circulation, PHSS break, Seismic
TRISO failure probability	Negligible TRISO fuel failure probability	Salt Spills, Reactivity Insertion, Increase in Heat Removal, Loss of Forced Circulation, PHSS break
Peak Flibe-cover gas interfacial temperature	Generally bounded by temperature-time curves derived from the assumed MHA Flibe-cover gas interfacial temperature-time curve	Salt Spills, Reactivity Insertion, Increase in Heat Removal, Loss of Forced Circulation, PHSS break
Peak vessel and core barrel temperatures	Bounded by both the maximum allowable temperature derived to limit excessive creep deformation and damage accumulation and by 750°C (highest vessel design temperature)	Salt Spills, Reactivity Insertion, Increase in Heat Removal, Loss of Forced Circulation, PHSS break
Minimum reactor vessel inner surface temperature	Above Flibe melting temperature	Loss of Forced Circulation (overcooling)
Airborne release fraction of spilled/splashed Flibe	Below airborne release fraction limit derived to bound total releases of the postulated event to less than the MHA	Salt Spills, Seismic
Volatile product formation from Flibe-air reaction	Negligible amount of additional volatile products formed	Salt Spills, PHSS break
Volatile product formation from Flibe chemical reaction with water, concrete, and/or construction materials (e.g., insulation, steel)	Negligible amount of additional volatile products formed	Salt Spill
Mass loss of pebble carbon matrix due to oxidation	Mass loss does not extend into the fueled zone	Salt Spills, PHSS break
Mass loss of structural graphite due to oxidation	Bounded by the MHA release	Salt Spills, PHSS break
Peak structural graphite temperature-time	Generally bounded by temperature-time curves derived from the assumed MHA structural graphite temperature-time curve	Salt Spills, Reactivity Insertion, Increase in Heat Removal, Loss of Forced Circulation, PHSS break