3/4.4.9 PRESSURE/TEMPERATURE LIMITS

REACTOR COOLANT SYSTEM

LIMITING CONDITION FOR OPERATION

3.4.9.1 The Reactor Coolant System (except the pressurizer) temperature and pressure shall be limited in accordance with the limit lines shown on Figures 3.4-2A, 3.4-2B and 3.4-2C during heatup/criticality, cooldown, and inservice leak and hydrostatic testing operations with:

a. A maximum heatup of 50°F, 60°F, 70°F or 80°F in any one hour period in accordance with Figure 3.4-2A.

b. A maximum cooldown rate based on:

RCS Temperature (Tc)	Maximum Cooldown Rate
$T_C > 200°F$	100°F per hour (constant) or 50°F in any half hour period (step)
$120°F \leq T_C \leq 200°F$	60°F per hour (constant) or 30°F in any half hour period (step)
$T_C < 120°F$	25°F per hour (constant) or 12.5°F in any half hour period (step)

c. A maximum temperature change of ≤ 10°F in any one hour period during inservice hydrostatic and leak testing operations above the heatup and cooldown limit curves.

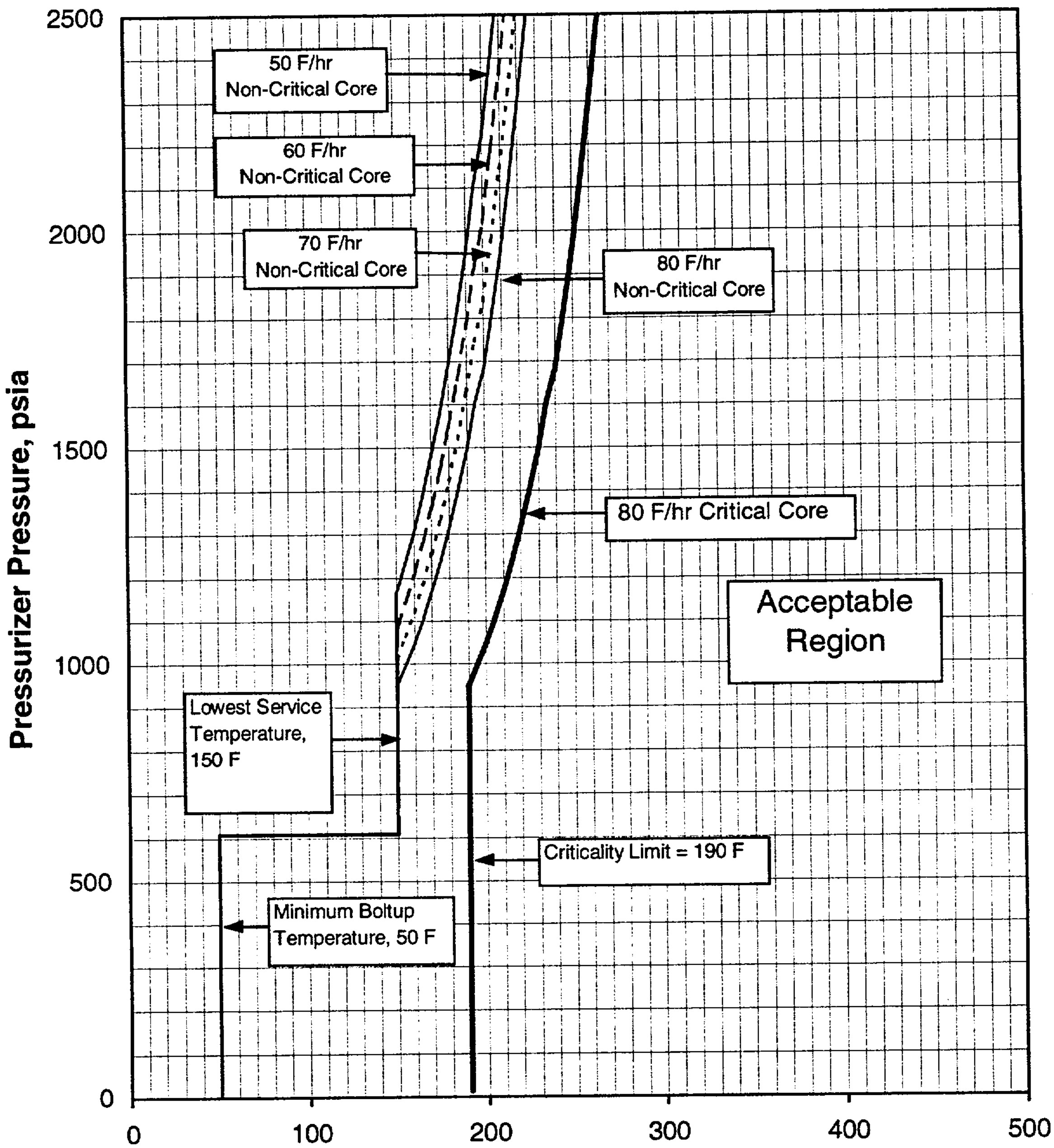
APPLICABILITY: At all times.

ACTION:

With any of the above limits exceeded, restore the temperature and/or pressure to within the acceptable region of the applicable curve within 30 minutes; perform an engineering evaluation to determine the effects of the out-of-limit condition on the fracture toughness properties of the Reactor Coolant System; determine that the Reactor Coolant System remains acceptable for continued operations or be in at least HOT STANDBY within the next 6 hours and reduce the RCS Tc and pressure to less than 200°F and less than 500 psia, respectively, within the following 30 hours.

Figure 3.4-2A

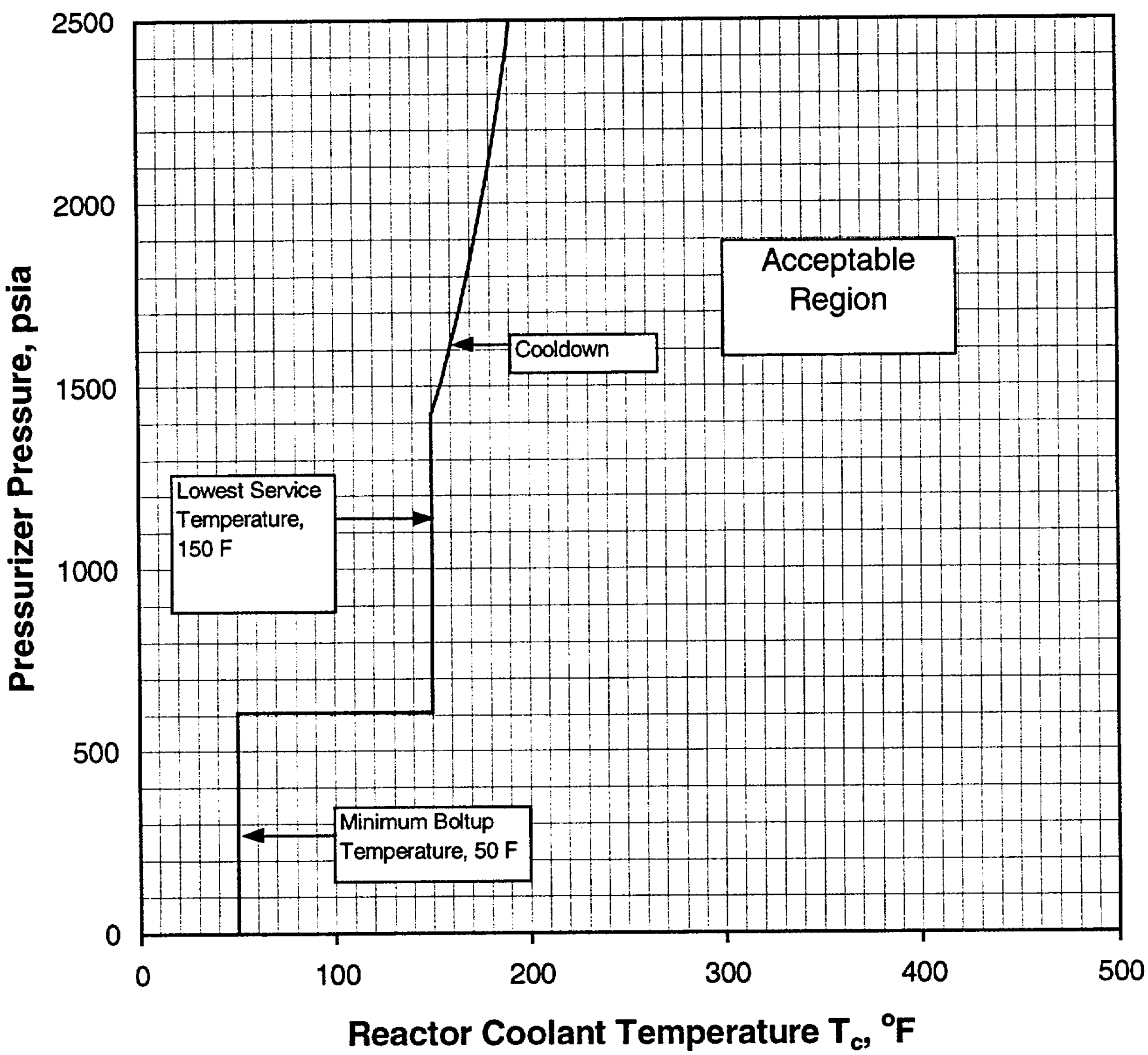
HEATUP CURVE – 32 EFPY
REACTOR COOLANT SYSTEM PRESSURE/TEMPERATURE LIMITS



Reactor Coolant Temperature T_c, °F
(Curves do not include margins for instrument uncertainties)

Figure 3.4-2B

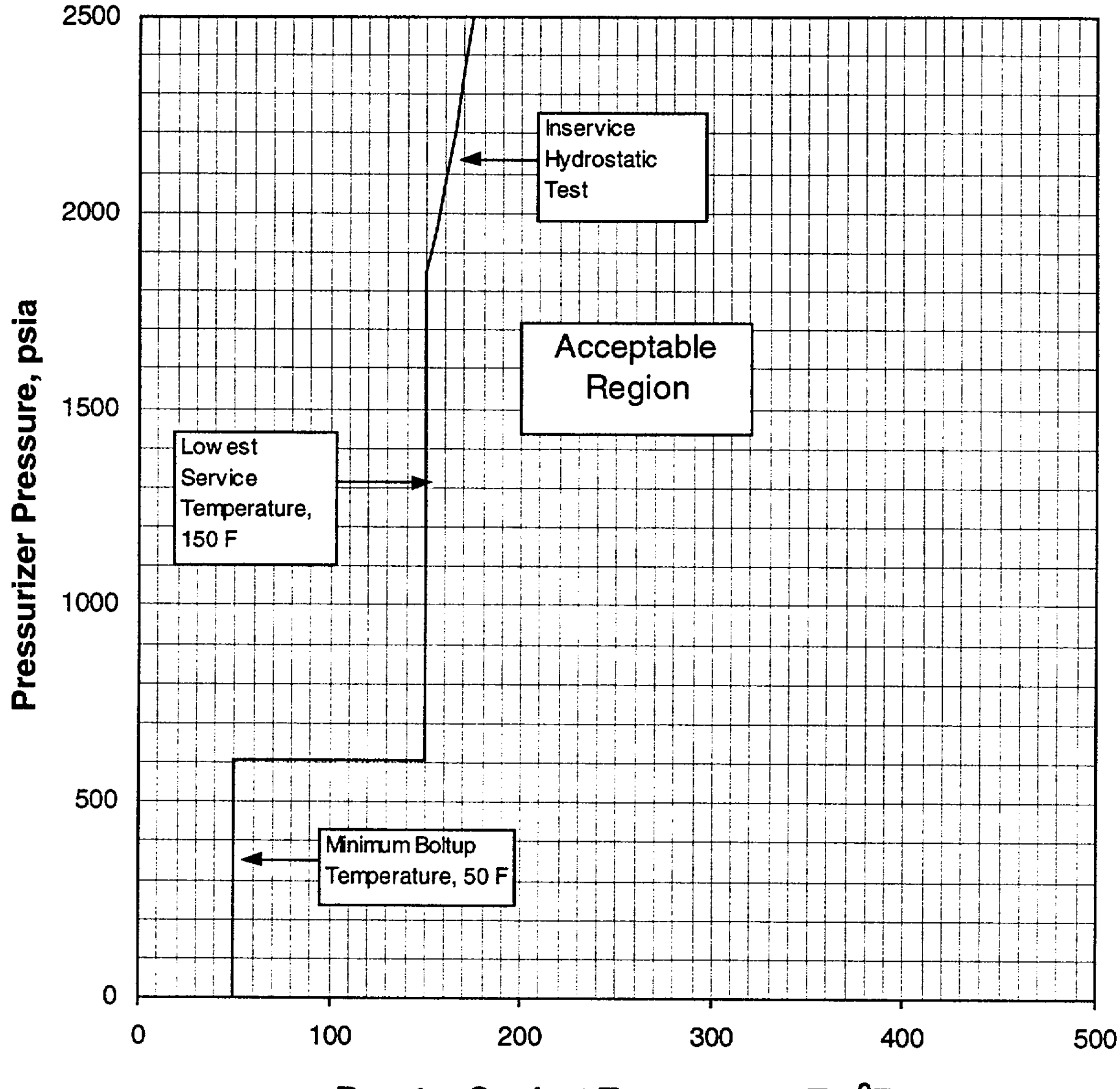
COOLDOWN CURVE – 32 EFPY
REACTOR COOLANT SYSTEM PRESSURE/TEMPERATURE LIMITS



(Curves do not include margins for instrument uncertainties)

Figure 3.4-2C

INSERVICE HYDROSTATIC TEST CURVE - 32 EFPY
REACTOR COOLANT SYSTEM PRESSURE/TEMPERATURE
LIMITS



(Curves do not include margins for instrument uncertainties)

LOW TEMPERATURE OVERPRESSURE PROTECTION (LTOP) SYSTEM

LIMITING CONDITION FOR OPERATION

3.4.12 The LTOP system shall be OPERABLE with each SIT isolated that is pressurized to ≥ 300 psig, and a maximum of one HPSI pump capable of injecting into the RCS and:

a. Two LTOP relief valves with a lift setting of ≤ 430 psig, or

b. The Reactor Coolant System depressurized with an RCS vent path ≥ 6.38 square inches.

APPLICABILITY: MODE 4 with T_C ≤ 220°F, MODE 5, MODE 6 with reactor vessel head in place.*

ACTION:

a. With one LTOP relief valve inoperable in MODE 4, restore the inoperable valve to OPERABLE status within 7 days or depressurize and vent the RCS through a ≥ 6.38 square inch vent path within the next 8 hours.

b. With one LTOP relief valve inoperable in MODE 5 or 6, restore the inoperable relief valve to OPERABLE status within 24 hours or depressurize and vent the RCS through a ≥ 6.38 square inch vent path within the next 8 hours.

c. With both LTOP relief valves inoperable, depressurize and vent the RCS through a ≥ 6.38 square inch vent path within 8 hours.

d. With a SIT not isolated and pressurized to ≥ 300 psig, isolate the affected SIT within 1 hour. If the affected SIT is not isolated within 1 hour, either:

(1) Depressurize the SIT to < 300 psig within the next 12 hours, or

(2) Increase cold leg temperature to > 220°F within the next 12 hours.

e. With more than one HPSI pump capable of injecting into the RCS, immediately initiate action to verify a maximum of one HPSI pump capable of injecting into the RCS.

f. The provisions of Specification 3.0.4 are not applicable.

* - when starting the first reactor coolant pump, the pressurizer water volume will be < 910 ft^3.

steam generator tube rupture accident in conjunction with an assumed steady state primary-to-secondary steam generator leakage rate of 1.0 GPM and a concurrent loss of offsite electrical power. The values for the limits on specific activity represent interim limits based upon a parametric evaluation by the NRC of typical site locations. These values are conservative in that specific site parameters of the Arkansas Nuclear One site, such as site boundary location and meteorological conditions, were not considered in this evaluation. The NRC is finalizing site specific criteria which will be used as the basis for the reevaluation of the specific activity limits of this site. This reevaluation may result in higher limits.

The ACTION statement permitting POWER OPERATION to continue for limited time periods with the primary coolant's specific activity > 1.0 µCi/gram DOSE EQUIVALENT I-131, but within the allowable limit shown on Figure 3.4-1, accommodates possible iodine spiking phenomenon which may occur following changes in THERMAL POWER.

Reducing Tavg to < 500°F prevents the release of activity should a steam generator tube rupture since the saturation pressure of the primary coolant is below the lift pressure of the atmospheric steam relief valves. The surveillance requirements provide adequate assurance that excessive specific activity levels in the primary coolant will be detected in sufficient time to take corrective action. Information obtained on iodine spiking will be used to assess the parameters associated with spiking phenomena. A reduction in frequency of isotopic analyses following power changes may be permissible if justified by the data obtained.

3/4.4.9 PRESSURE/TEMPERATURE LIMITS

All components in the Reactor Coolant System are designed to withstand the effects of cyclic loads due to system temperature and pressure changes. These cyclic loads are introduced by normal load transients, reactor trips, and startup and shutdown operations. The various categories of load cycles used for design purposes are provided in Section 5.2.1.5 of the FSAR. During startup and shutdown, the rates of temperature and pressure changes are limited so that the maximum specified heatup and cooldown rates do not exceed the design assumptions and satisfy the stress limits for cyclic operation.

Operation within the limits of the appropriate heatup and cooldown curves assure the integrity of the reactor vessel against fracture induced by combined thermal and pressure stresses. As the vessel is subjected to increasing fluence, the toughness of the limiting material continues to decline, and even more restrictive pressure/temperature limits must be observed.

The reactor vessel materials have been tested to determine their initial RT_{NDT}. Reactor operation and resultant fast neutron (E > 1 Mev) irradiation will cause an increase in the RT_{NDT}. The heatup/criticality, cooldown, and hydrostatic test limit curves for 32 EFPY shown on Figure 3.4-2A, 3.4-2B and 3.4-2C include predicted adjustments for this shift in RT_{NDT} at the end of the applicable service period, as well as adjustments for the location and for possible errors in the pressure and temperature sensing instruments. It should be noted that the location adjustment considered the operation of three RCPs from a RCS temperature above the LTOP enable temperature and a maximum of two RCPs operating while below the LTOP enable temperature. Instrument uncertainty in these curves is not included, but is added in station procedures.

The shift in the limiting material fracture toughness, as represented by RT_{NDT}, is calculated using Regulatory Guide 1.99, Revision 2. For 32 EFPY, at the 1/4t position, the adjusted reference temperature (ART) value is 112.7°F. At the 3/4t position the ART value is 98.8°F. These values are conservatively based on a reactor vessel inner surface fluence of 3.79×10^{19}nvt. The fluence at the 1/4t point is 2.29×10^{19}nvt and the fluence of the 3/4t point is 8.92×10^{18}nvt. These values are used with procedures developed in the ASME Boiler and Pressure Vessel Code, Section III, Appendix G and Code Case N-641 to calculate heatup and cooldown limits in accordance with the requirements of 10 CFR Part 50, Appendix G.

To develop composite pressure/temperature limits for the heatup transient, the isothermal, 1/4t heatup, and 3/4t heatup pressure/temperature limits are compared for a given thermal rate. Then the most restrictive pressure/temperature limits are combined over the complete temperature interval resulting in a composite limit curve for the reactor vessel beltline for the heatup event.

To develop composite pressure/temperature limit for the cooldown event, the isothermal pressure/temperature limits must be calculated. The isothermal pressure/ temperature limit is then compared to the pressure/temperature limit associated with both the constant cooldown rate and the corresponding step change rate (an instantaneous drop in temperature followed by a hold period). The more restrictive allowable pressure/ temperature limit is chosen resulting in a composite limit curve for the reactor vessel beltline.

Both 10CFR Part 50, Appendix G and ASME Code Section III, Appendix G, require the development of pressure/temperature limits which are applicable to inservice hydrostatic tests. The minimum temperature for the inservice hydrostatic test pressure can be determined by entering the curve at the test pressure and locating the corresponding temperature. This curve is shown for 32 EFPY on Figure 3.4-2C.

Similarly, 10CFR Part 50 specifies that core critical limits be established based on material considerations. This limit is shown on the heatup curve, Figure 3.4-2A. Note that this limit does not consider the core reactivity safety analyses that actually control the temperature at which the core can be brought critical.

The Lowest Service Temperature is the minimum allowable temperature at pressures above 20% of the pre-operational system hydrostatic test pressure (624 psia). This temperature is defined as equal to the most limiting RT_{NDT} for the balance of the Reactor Coolant System component (conservatively estimated as 50°F) plus 100°F, per Article NB 2332 of Section III of the ASME Boiler and Pressure Vessel Code.

The horizontal line between the minimum boltup temperature and the Lowest Service Temperature is defined by the ASME Boiler and Pressure Vessel Code as 20% of the pre-operational hydrostatic test pressure.

The minimum boltup temperature is the minimum allowable temperature at pressures below 20% of the pre-operational system hydrostatic test pressure. The minimum is defined as the initial RT_{NDT} for the material of the higher stressed region of the reactor vessel plus any effects for irradiation per Article G-2222 of Section III of the ASME Boiler and Pressure Vessel Code. The initial reference temperature of the reactor vessel and closure head flanges was determined using the certified material test reports and Branch Technical Position MTEB 5-2. The maximum initial RT_{NDT} associated with the stressed region of the vessel flange is 30°F. The minimum boltup temperature of 30°F plus a 20°F conservatism is 50°F.

The number of reactor vessel irradiation surveillance specimens and the frequencies for removing and testing these specimens are provided SAR Table 5.2-12 to assure compliance with the requirements of Appendix H to 10 CFR Part 50.

The limitations imposed on the pressurizer heatup and cooldown rates are provided to assure that the pressurizer is operated within the design criteria assumed for the fatigue analysis performed in accordance with the ASME Code requirements.

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3/4.4.12 LOW TEMPERATURE OVERPRESSURE PROTECTION SYSTEM

Low temperature overpressure protection (LTOP) of the RCS, including the reactor vessel, is provided by redundant relief valves on the pressurizer which discharge from a single discharge header. Each relief valve is isolated from the RCS by two motor operated block valves. Each LTOP relief valve is a direct action, spring-loaded relief valve, with orifice area of 6.38 in^2 and a lift setting of ≤ 430 psig, and is capable of protecting the RCS from overpressurization from the limiting transient. The relief valves will be able to mitigate (1) the starting of the first reactor coolant pump when the pressurizer water volume is < 910 ft^3, and when the secondary water temperature of the steam generator is less than or equal to 100°F above the RCS cold leg temperature (energy addition event), or (2) the simultaneous injection of one HPSI pump and all three charging pumps (mass addition event). The action to prevent the capability of injection of more than one HPSI pump into the RCS will typically be accomplished by placing the HPSI pumps in pull-to-lock. The limiting LTOP design basis event is the energy addition event. The analyses assume that the safety injection tanks (SITs) are either isolated or depressurized such that they are unable to challenge the LTOP relief setpoints.

Since neither the LTOP relief valves nor the RCS vent is analyzed for the pressure transient produced from SIT injection, the LCO requires each SIT that is pressurized to ≥ 300 psig to be isolated. The isolated SITs must have their discharge valves closed and the associated MOV power supply breaker in the open position. The individual SITs may be unisolated when pressurized to < 300 psig. The associated instrumentation uncertainty is not included in the 300 psig value and therefore, the procedural value for unisolating the SITs with the LTOPs in service will be reduced.

The LTOP system, in combination with the RCS heatup and cooldown limitations of LCO 3.4.9.1 and restrictions on RCP operation, provides assurance that the reactor vessel non-ductile fracture limits are not exceeded during the design basis event at low RCS temperatures. These non-ductile fracture limits are identified as LTOP pressure-temperature (P-T) limits, which were specifically developed to provide a basis for the LTOP system. These LTOP P-T limits, along with the LTOP enable temperature, were developed using guidance provided in ASME Code Section XI, Division 1, Code Case N-641. This code case allows using an alternate means of determining LTOP P/T condition but limits "the maximum pressure in the vessel to 100% of the pressure" using the K_{1C} approach allowed by the Code Case.

The enable temperature of the LTOP isolation valves is based on any RCS cold leg temperature reaching 220°F (including a 20°F uncertainty). Although each relief valve is capable of mitigating the design basis LTOP event, both LTOP relief valves are required to be OPERABLE below the enable temperature to meet the single failure criterion of NRC Branch Technical Position RSB 5-2, unless any RCS vent path of 6.38 in^2 (equivalent relief valve orifice area) or larger is maintained.