15.2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

15.2.1 SAFETY LIMIT, REACTOR CORE

Applicability:

Applies to the limiting combinations of thermal power, reactor coolant system pressure, and coolant temperature during operation.

Objective:

To maintain the integrity of the fuel cladding.

Specification:

1. The combination of thermal power level, coolant pressure, and coolant temperature shall not exceed the limits shown in Figure 15.2.1-1 for Units 1 and ~~Figure 15.2.1-2 for Unit~~ 2*. The safety limit is exceeded if the point defined by the combination of reactor coolant system average temperature and power level is at any time above the appropriate pressure line.

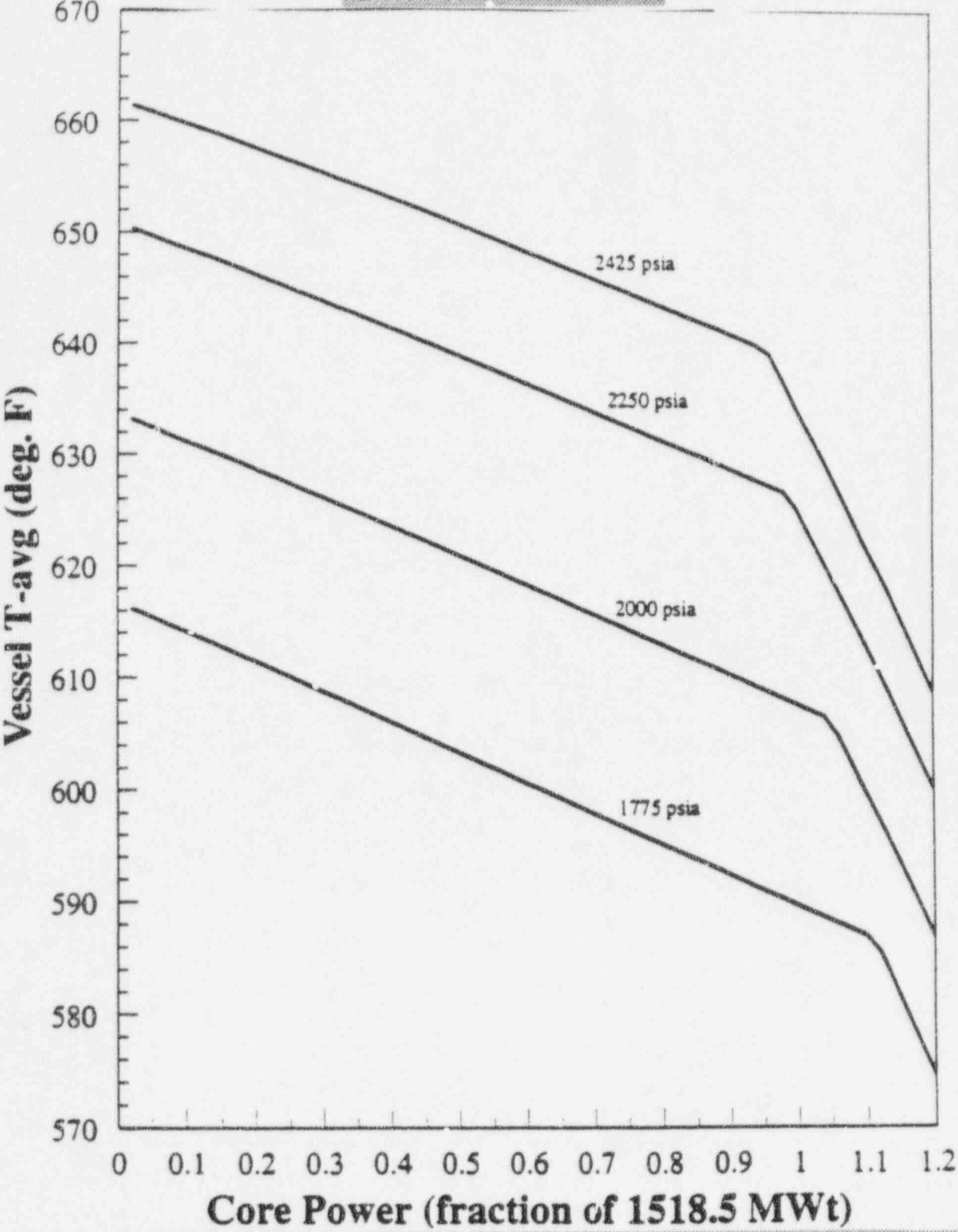
Basis:

The restrictions of this safety limit prevent overheating of the fuel and possible cladding perforation which would result in the release of fission products to the reactor coolant. Overheating of the fuel cladding is prevented by restricting fuel operation to within the nucleate boiling regime where the heat transfer coefficient is large and the cladding surface temperature is slightly above the coolant saturation temperature.

Operation above the upper boundary of the nucleate boiling regime could result in excess cladding temperature because of the onset of departure from nucleate boiling (DNB) and the resultant sharp reduction in heat transfer coefficient. DNB is not a directly measurable parameter during operation and therefore thermal power and Reactor Coolant temperature and pressure have been related to DNB.

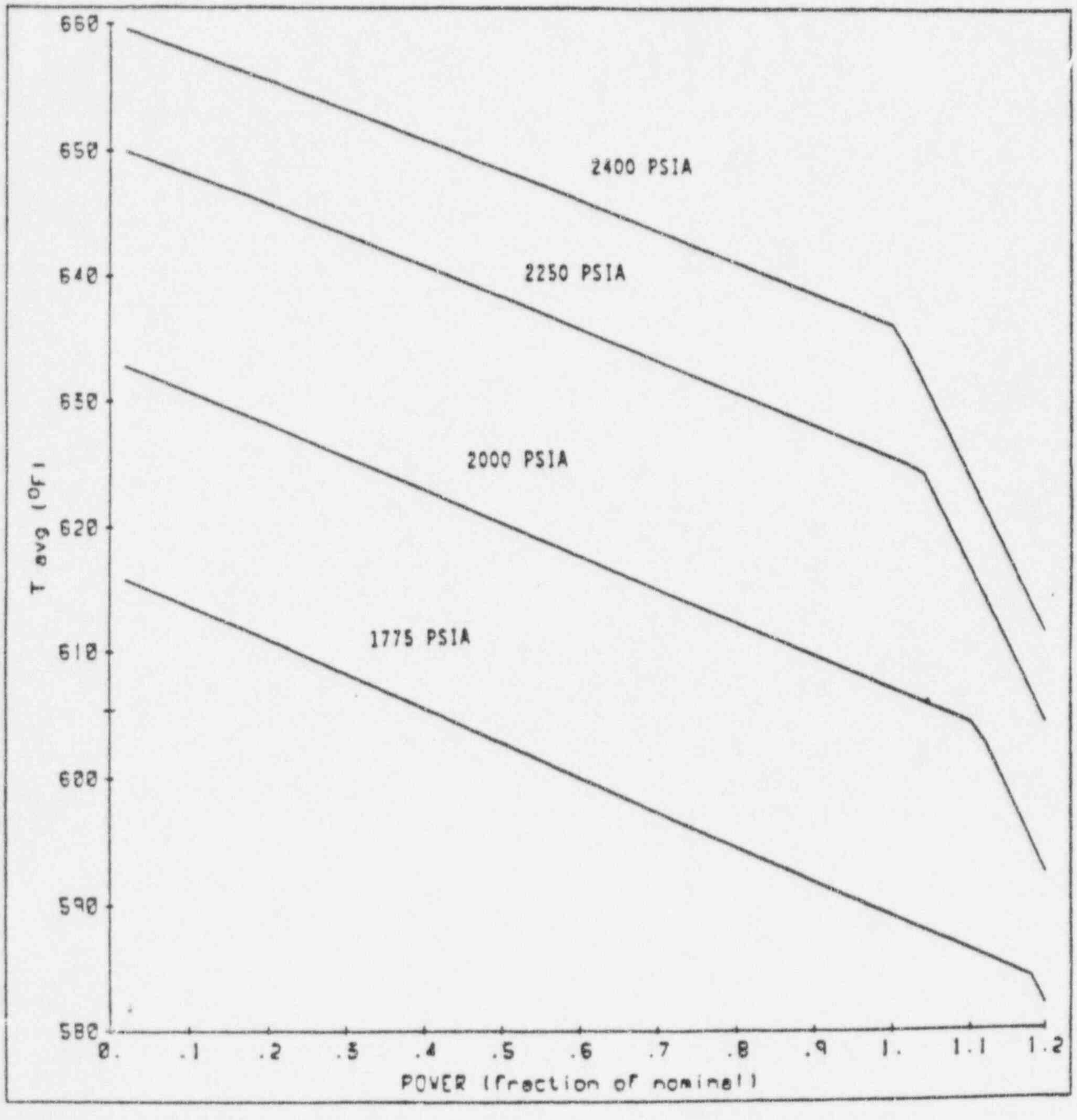
* Figure 15.2.1-1 applies to Unit 2 following U2R22 and to Unit 1 following U1R24. Prior to U1R24, Figure 15.2.1-2 applies to Unit 1.

Figure 15.2.1-1
POINT BEACH NUCLEAR PLANT UNITS 1 AND 2*
REACTOR CORE SAFETY LIMITS



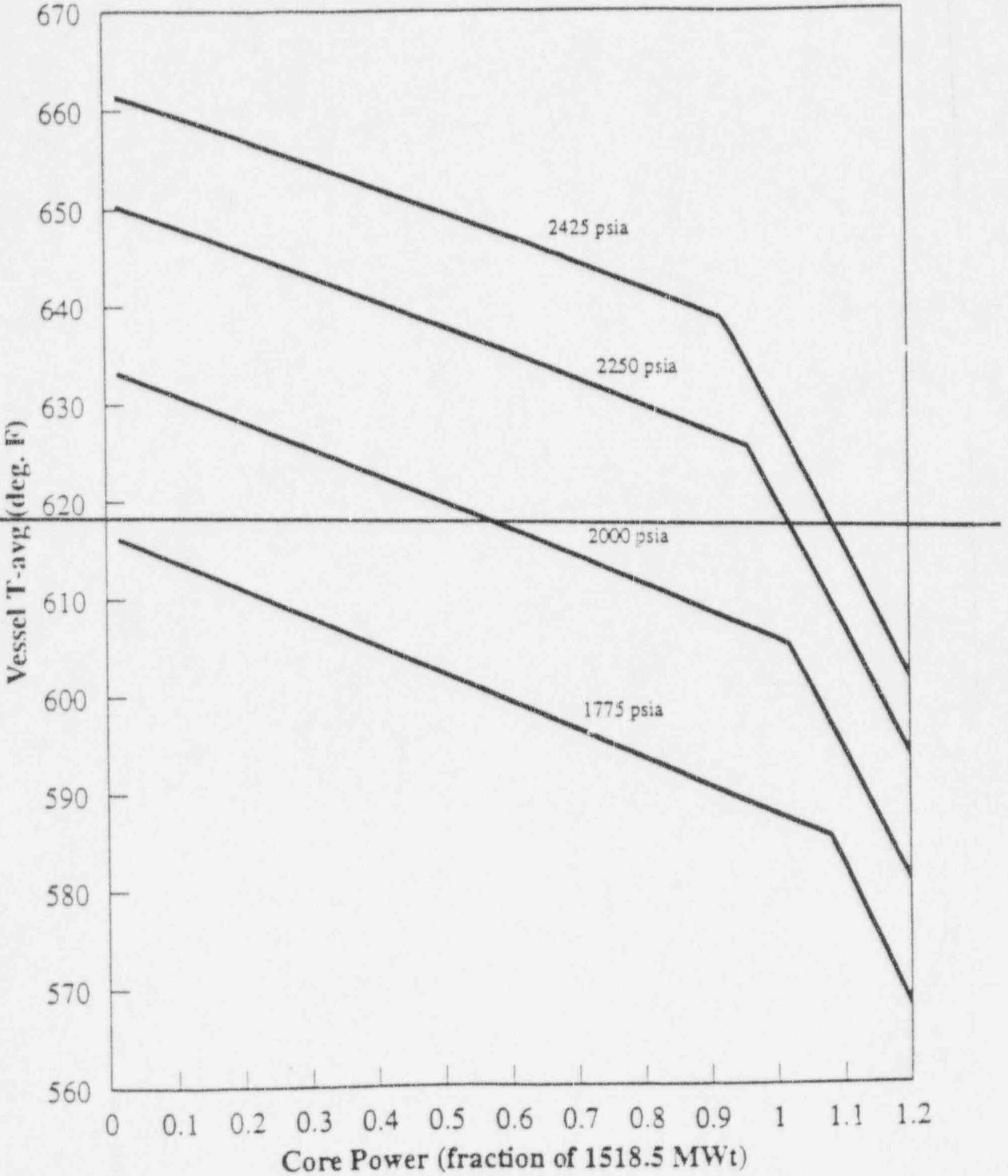
* This figure applies to Unit 2 following U2R22 and to Unit 1 following U1R24. Prior to U1R24, Figure 15.2.1-2 applies to Unit 1.

Figure 15.2.1-~~1~~2*
REACTOR CORE SAFETY LIMITS
POINT BEACH UNIT 1



* This figure applies to Unit 1 prior to U1R24. Following U1R24, Figure 15.2.1-1 applies to Unit 1.

Figure 15.2.1-2
REACTOR CORE SAFETY LIMITS
POINT BEACH UNIT 2



(3) Low pressurizer pressure - ≥1865 psig for operation at 2250 psia primary system pressure
≥1790 psig for operation at 2000 psia primary system pressure

(4) Overtemperature

$$\Delta T\left(\frac{1}{1+\tau_3 S}\right)$$
$$\leq \Delta T_o\left(K_1 - K_2\left(T\left(\frac{1}{1+\tau_4 S}\right) - T'\right)\left(\frac{1+\tau_1 S}{1+\tau_2 S}\right) + K_3(P-P') - f(\Delta I)\right)$$

where (values are applicable to operation at both 2000 psia and 2250 psia unless otherwise indicated)

ΔT_o	=	indicated ΔT at rated power, °F
T	=	average temperature, °F
T′	≤	57~~3~~2.9°F* ~~(Unit 1)~~
~~T′~~	~~≤~~	~~570.0°F (Unit 2)~~
P	=	pressurizer pressure, psig
P′	=	2235 psig (2250 psia operation only)
P′	=	1985 psig (2000 psia operation only)*
K_1	≤	~~1.30~~ 1.26 (2250 psia operation only)
K_1	≤	1.14 (2000 psia operation only)*
K_2	=	~~0.0200~~ 0.025 (2250 psia operation only)
K_2	=	0.022 (2000 psia operation only)*
K_3	=	~~0.000791~~ 0.0013 (2250 psia operation only)
K_3	=	0.001 (2000 psia operation only)*
τ_1	=	25 sec
τ_2	=	3 sec
τ_3	=	2 sec for Rosemont or equivalent RTD
	=	0 sec for Sostman or equivalent RTD
τ_4	=	2 sec for Rosemont or equivalent RTD
	=	0 sec for Sostman or equivalent RTD

and $f(\Delta I)$ is an even function of the indicated difference between top and bottom detectors of the power-range nuclear ion chambers; with gains to be selected based on measured instrument response during plant startup tests, where q_t and q_b are the percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of rated power, such that:

(a) for $q_t - q_b$ within -17, +5 percent, $f(\Delta I) = 0$.

(b) for each percent that the magnitude of $q_t - q_b$ exceeds +5 percent, the ΔT trip setpoint shall be automatically reduced by an equivalent of 2.0 percent of rated power ~~for Unit 1, or by an equivalent of 3.1 percent of rated power for Unit 2~~.

* These values apply to Unit 2 following U2R22 and to Unit 1 following U1R24. Prior to U1R24, the values for Unit 1 are: T′ ≤ 573.9°F, P′ = 2235 psig, $K_1 \leq 1.30$, $K_2 = 0.0200$, and $K_3 = 0.000791$.

(c) for each percent that the magnitude of $q_t - q_b$ exceeds -17 percent, the ΔT trip setpoint shall be automatically reduced by an equivalent of 2.0 percent of rated power.

(5) Overpower $\Delta T \left(\frac{1}{1+\tau_3 S}\right)$

$$\leq \Delta T_o \left[K_4 - K_5 \left(\frac{\tau_5 S}{\tau_5 S+1}\right)\left(\frac{1}{1+\tau_4 S}\right) T - K_6 \left[T\left(\frac{1}{1+\tau_4 S}\right) - T'\right]\right]$$

where (values are applicable to operation at both 2000 psia and 2250 psia)

ΔT_o	=	indicated ΔT at rated power, °F
T	=	average temperature, °F
T′	≤	57~~3~~2.9°F* ~~(Unit 1)~~
~~T′~~	~~≤~~	~~570.0°F (Unit 2)~~
K_4	≤	~~1.089~~ 1.09 of rated power*
K_5	=	0.0262 for increasing T
	=	0.0 for decreasing T
K_6	=	0.00123 for T ≥ T′
	=	0.0 for T < T′
τ_5	=	10 sec
τ_3	=	2 sec for Rosemont or equivalent RTD
		0 sec for Sostman or equivalent RTD
τ_4	=	2 sec for Rosemont or equivalent RTD
		0 sec for Sostman or equivalent RTD

(6) Undervoltage - ≥75 percent of normal voltage

(7) Indicated reactor coolant flow per loop - ≥90 percent of normal indicated loop flow

(8) Reactor coolant pump motor breaker open

 (a) Low frequency set point ≥55.0 HZ

 (b) Low voltage set point ≥75 percent of normal voltage.

* These values apply to Unit 2 following U2R22 and to Unit 1 following U1R24. Prior to U1R24, the values for Unit 1 are: T′ ≤ 573.9°F and K_4 ≤ 1.09 of rated power.

With normal axial power distribution, the reactor trip limit, with allowance for errors[2], is always below the core safety limit as shown on Figures 15.2.1-1 ~~for Unit 1~~ and ~~Figure~~ 15.2.1-2 ~~for Unit 2~~. If axial peaks are greater than design, as indicated by the difference between top and bottom power range nuclear detectors, the reactor trip limit is automatically reduced[6][7].

The overpower, overtemperature and pressurizer pressure system setpoints include the effect of reduced system pressure operation (including the effects of fuel densification). The setpoints will not exceed the core safety limits as shown in Figures 15.2.1-1 ~~for Unit 1~~ and ~~Figure~~ 15.2.1-2 ~~for Unit 2~~.

The overpower limit criteria is that core power be prevented from reaching a value at which fuel pellet centerline melting would occur. The reactor is prevented from reaching the overpower limit condition by action of the nuclear overpower and overpower ΔT trips.

The high and low pressure reactor trips limit the pressure range in which reactor operation is permitted. The high pressurizer pressure reactor trip setting is lower than the set pressure for the safety valves (2485 psig) such that the reactor is tripped before the safety valves actuate. The low pressurizer pressure reactor trip trips the reactor in the unlikely event of a loss-of-coolant accident[4].

The low flow reactor trip protects the core against DNB in the event of either a decreasing actual measured flow in the loops or a sudden loss of power to one or both reactor coolant pumps. The setpoint specified is consistent with the value used in the accident analysis[8]. The low loop flow signal is caused by a condition of less than 90 percent flow as measured by the loop flow instrumentation. The loss of power signal is caused by the reactor coolant pump breaker opening

G. OPERATIONAL LIMITATIONS

The following DNB related parameters shall be maintained within the limits shown during Rated Power operation:

1. T_{avg} shall be maintained ~~below 578°F.~~ ≥557°F and ≤573.9°F.*

2. Reactor Coolant System (RCS) pressurizer pressure shall be maintained:
   ~~a. Unit 1:~~ ≥2205 psig during operation at 2250 psia, or
   ≥1955 psig during operation at 2000 psia.
   ~~b. Unit 2: ≥1955 psig during operation at 2000 psia.~~

3. Reactor Coolant System raw measured Total Flow Rate ~~(See Basis)~~ shall be maintained ≥181,800 gpm..

   ~~a. Unit 1 ≥ 181,800 gpm Unit 1~~
   ~~b. Unit 2 ≥ 174,000 gpm Unit 2*~~

Basis:

The reactor coolant system total flow rate ~~for Unit 1~~ of 181,800 gpm is based on an assumed measurement uncertainty of 2.1 percent over thermal design flow (178,000 gpm). ~~The reactor coolant system total flow rate for Unit 2 at rated power is 174,000 gpm. This is based on an assumed measurement uncertainty of 2.1 percent over a thermal design flow of 170,400 gpm. However, Unit 2 is analyzed to support operation with a reactor coolant system total flow rate limit of 169,500 gpm. This is based on an assumed measurement uncertainty of 2.1 percent over a thermal design flow of 166,000 gpm. If the Unit 2 RCS raw measured total flow rate is less than 174,000 gpm but greater than or equal to 169,500 gpm, operation is limited to less than or equal to 98% rated power as described in the note to Specification 15.3.1.G.3.b.~~ The raw measured flow is based upon the use of normalized elbow tap differential pressure which is calibrated against a precision flow calorimetric at the beginning of each cycle.

* These values apply to Unit 2 following U2R22 and to Unit 1 following U1R24. Prior to U1R24, T_{avg} for Unit 1 shall be maintained below 578°F.

~~* For Unit 2: If the Reactor Coolant System raw measured total flow rate is <174,000 gpm but ≥169,500 gpm, Unit 2 shall be limited to ≤ 98% rated power.~~