REPLACE

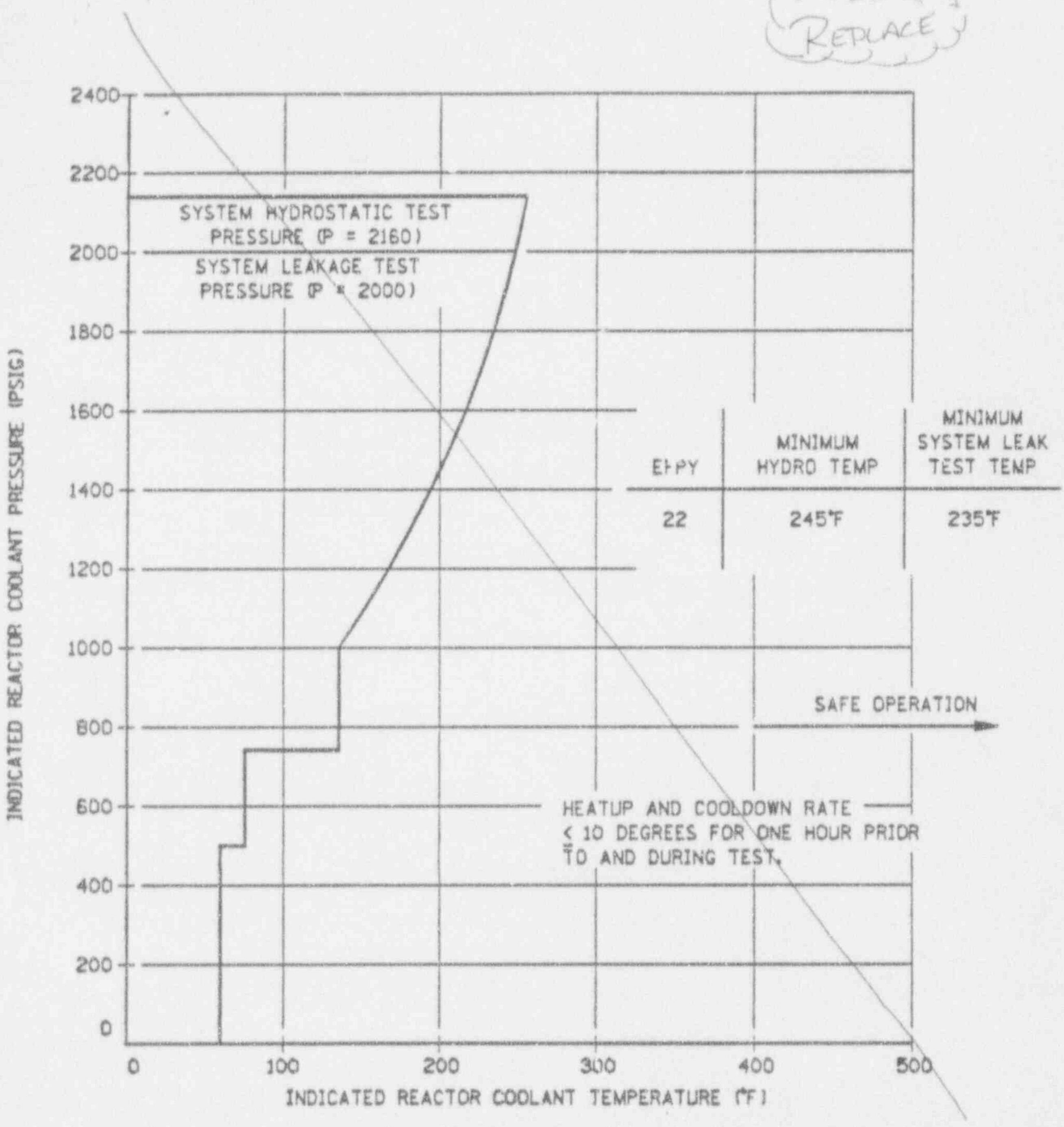
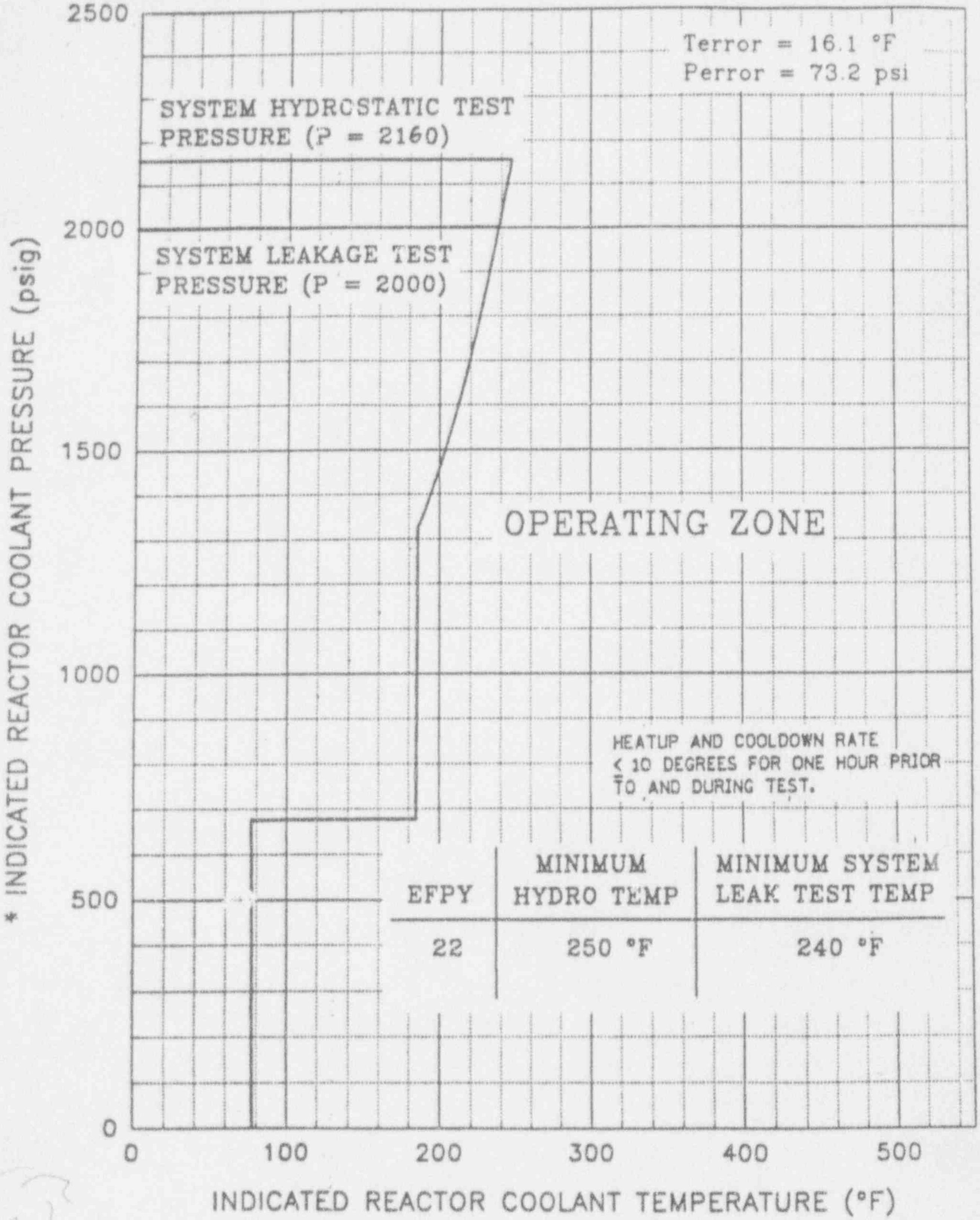


FIGURE 3.4-3
CONNECTICUT YANKEE LIMIT CURVE FOR HYDROSTATIC AND LEAK TESTING
APPLICABLE FOR 22.0 EFFECTIVE FULL POWER YEARS.
(T_{ERROR} = 10°F, P_{ERROR} = 60 PSIG)



*AS INDICATED BY THE WIDE RANGE PRESSURE TRANSMITTERS

FIGURE 3.4-3
HADDAM NECK LIMIT CURVE FOR HYDROSTATIC AND LEAK TESTING FOR 22 EFFECTIVE FULL POWER YEARS

REPLACE

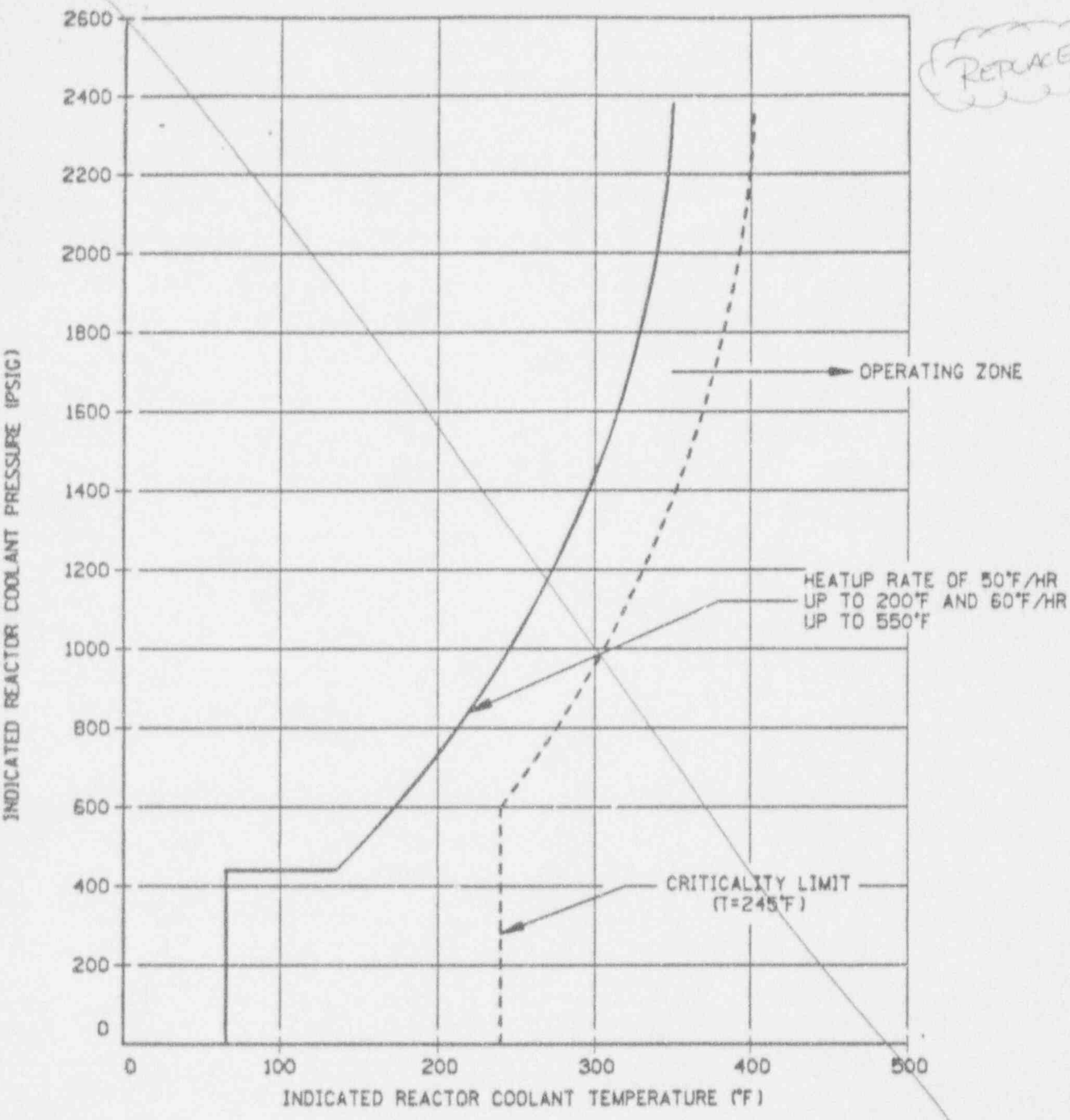
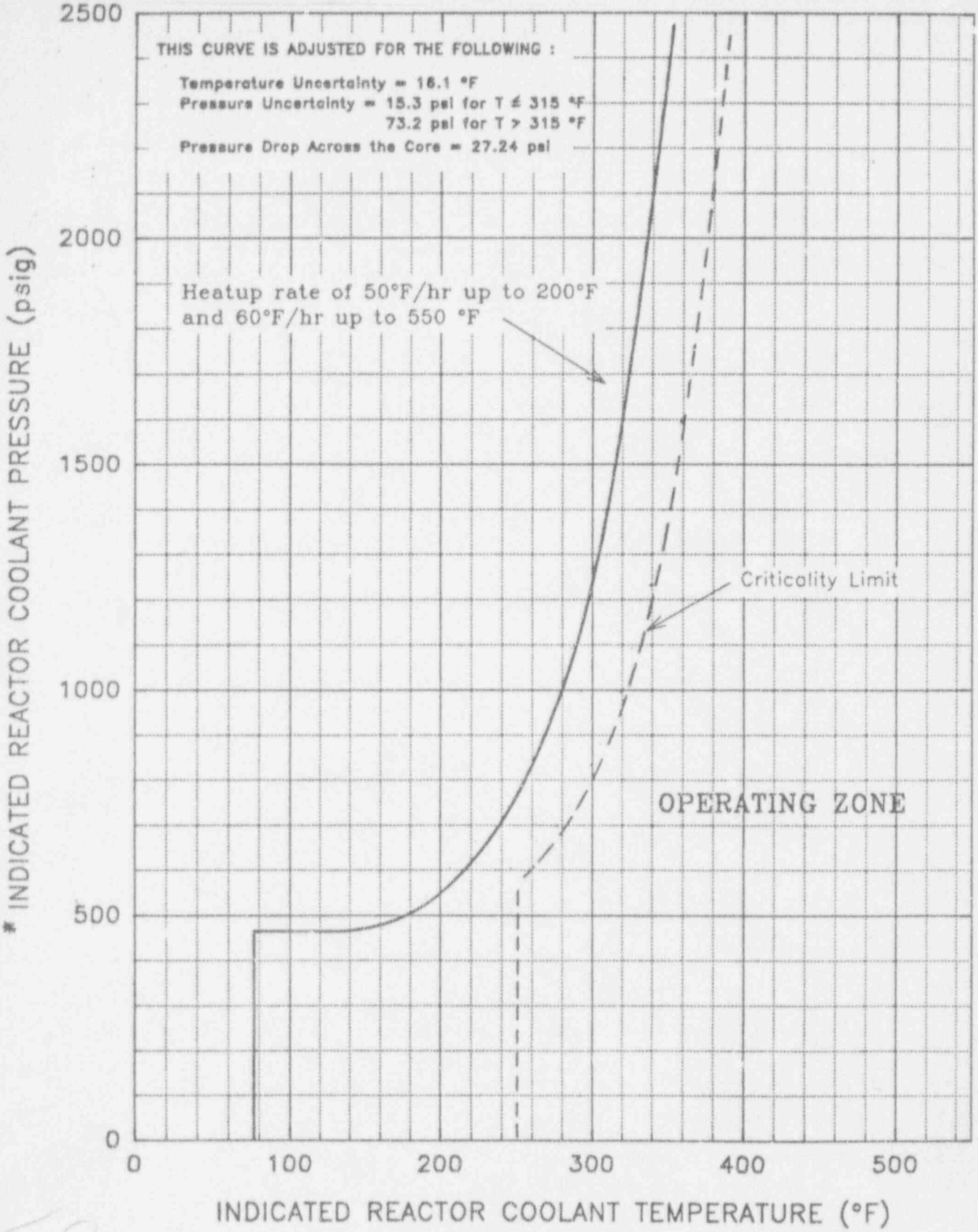


FIGURE 3.4-4
CONNECTICUT YANKEE REACTOR COOLANT SYSTEM HEATUP LIMITATIONS FOR 22.0 EFFECTIVE FULL POWER YEARS
(T_{ERROR} = 10°F, P_{ERROR} = 60 PSIG)



NEW

*AS INDICATED BY THE NARROW RANGE PRESSURE TRANSMITTER FOR T ≤ 315°F AND THE WIDE RANGE FOR T > 315°F

FIGURE 3.4-4
HADDAM NECK REACTOR COOLANT SYSTEM HEATUP LIMITATIONS FOR 22 EFFECTIVE FULL POWER YEARS

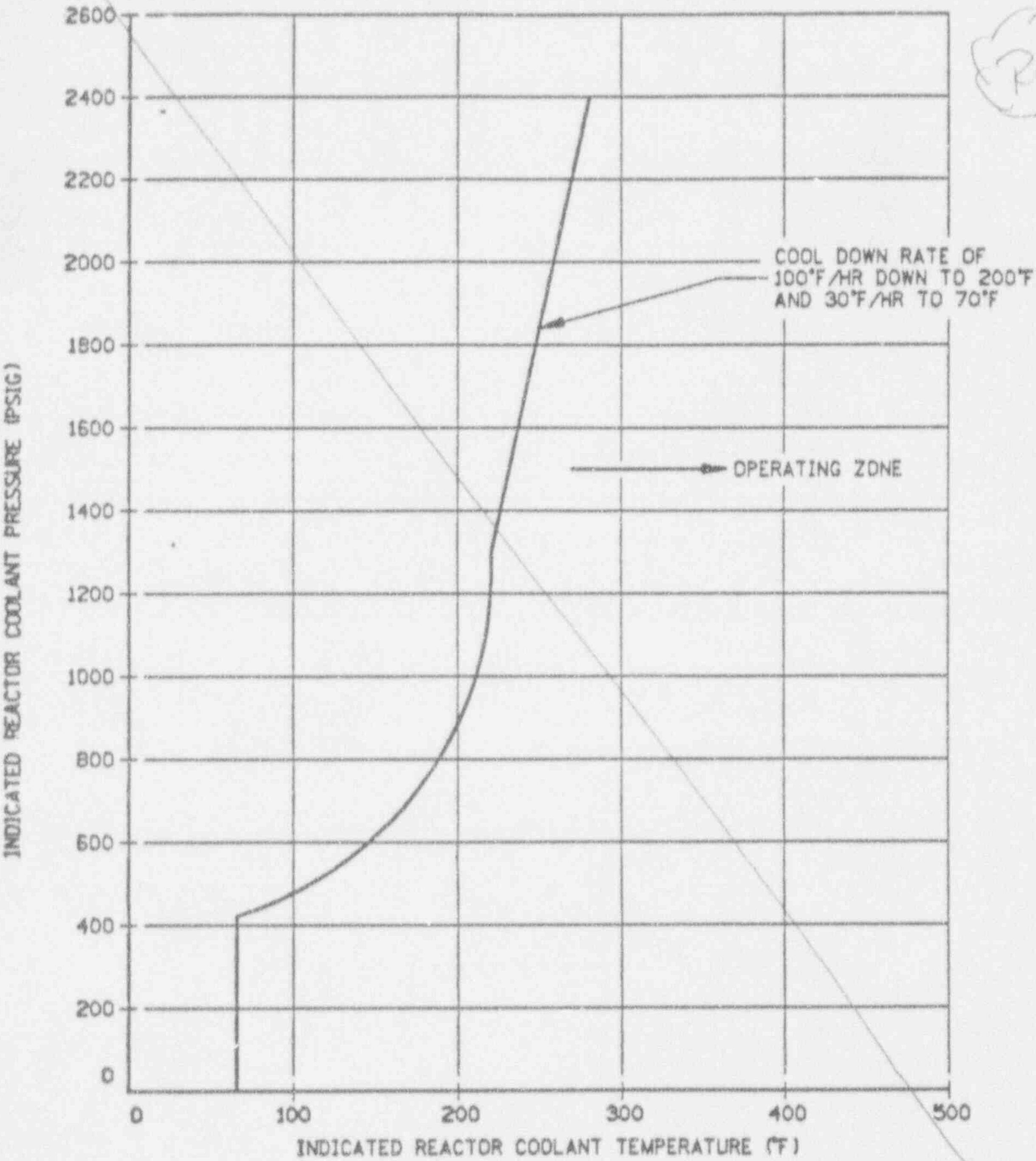
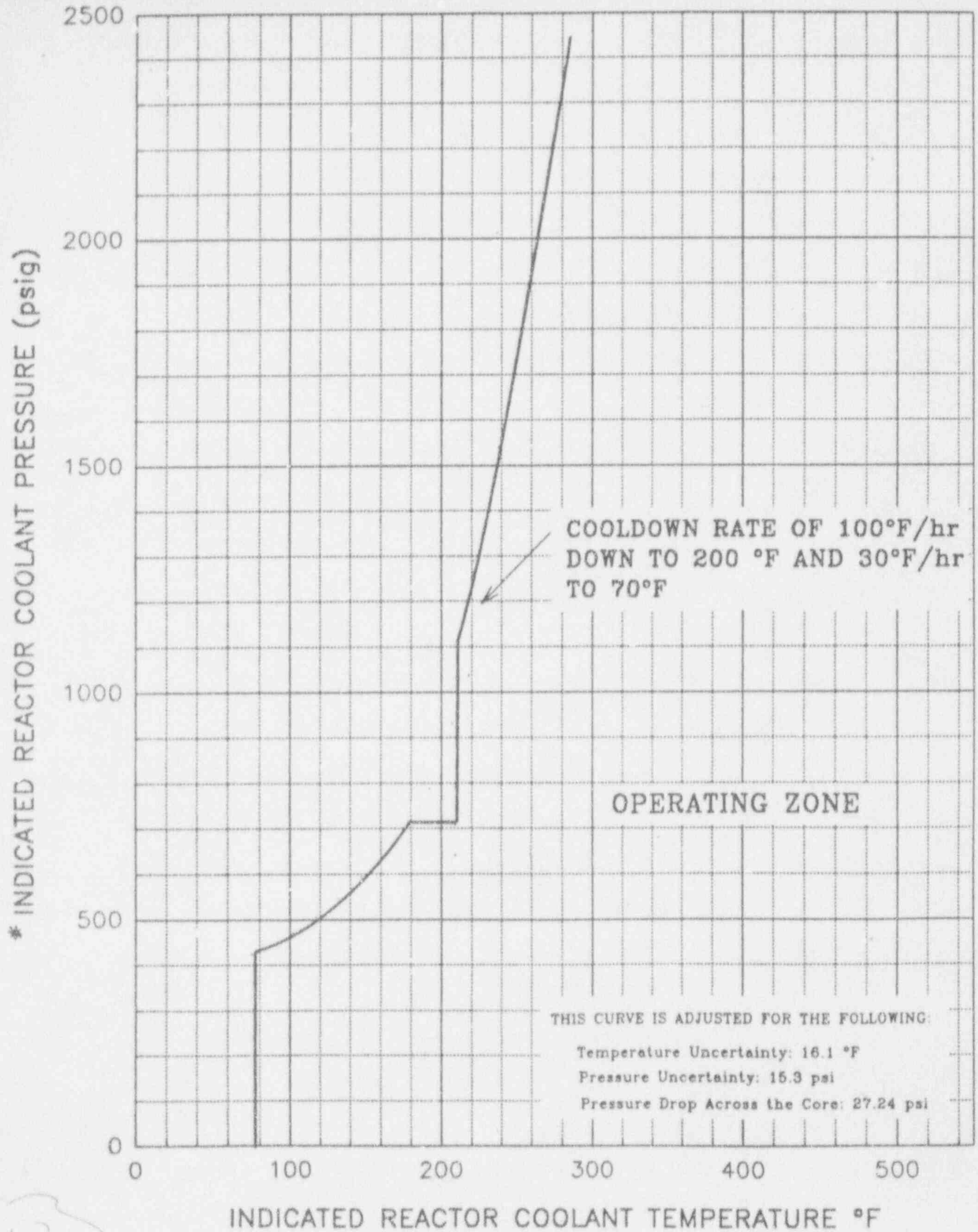


FIGURE 3.4-5
CONNECTICUT YANKEE REACTOR COOLANT SYSTEM COOLDOWN
LIMITATIONS FOR 22.0 EFFECTIVE FULL POWER YEARS
(T_{ERROR} = 10°F, P_{ERROR} = 60 PSIG)



NEW

*AS INDICATED BY THE NARROW RANGE PRESSURE TRANSMITTERS

FIGURE 3.4-5
HADDAM NECK REACTOR COOLANT SYSTEM COOLDOWN
LIMITATIONS FOR 22 EFFECTIVE FULL POWER YEARS

3/4.4.8 SPECIFIC ACTIVITY (Continued)

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 reactor coolant will be detected in sufficient time to take corrective action. A reduction in frequency of isotopic analysis following power changes may be permissible if justified by the data obtained.

3/4.4.9 PRESSURE/TEMPERATURE LIMITS

The temperature and pressure changes during heatup and cooldown are limited to be consistent with the requirements given in the ASME Boiler and Pressure Vessel Code, Section III, Appendix G:

1. The reactor coolant temperature and pressure and system heatup and cooldown rates (with the exception of the pressurizer) shall be limited in accordance with Figures 3.4-3, 3.4-4 and 3.4-5 for the service period specified thereon:

   a. Allowable combinations of pressure and temperature for specific temperature change rates are below and to the right of the limit lines shown. ~~Limit lines for cooldown rates between those presented may be obtained by interpolation; and~~

   b. Figures 3.4-3, 3.4-4 and 3.4-5 define limits to assure prevention of non-ductile failure only. For normal operation, other inherent plant characteristics, e.g., pump heat addition and pressurizer heater capacity, may limit the heatup and cooldown rates that can be achieved over certain pressure-temperature ranges.

2. These limit lines shall be calculated periodically using the methods provided ~~below,~~ IN THE ASME B&PV, SECTION XI, APPENDIX G,

3. The secondary side of the steam generator must not be pressurized above 200 psig if the temperature of the steam generator is below 70°F,

4. The pressurizer heatup and cooldown rates shall not exceed 100°F/hr and 200°F/hr, respectively.

5. System preservice hydrotests and inservice leak and hydrotests shall be performed at pressures in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section XI.

INSERT 1

~~The fracture toughness properties of the ferritic materials in the reactor vessel are determined in accordance with the NRC Standard Review Plan, ASTM E185-73, and in accordance with additional reactor vessel requirements. These properties are then evaluated in accordance with Appendix G of the 1976 Summer Addenda to Section III of the ASME Boiler and Pressure Vessel Code and the calculation methods described in WCAP-7924-A, "Basis for Heatup and Cooldown Limit Curves", April 1975.~~

INSERT 1

6. The pressure/temperature limit curves include additional margin to compensate for instrument uncertainty, differential system elevation and pressure drop across the core as described in the curves. The instrument uncertainty was obtained based on the fact that the narrow range pressure transmitters will be used whenever the RCS pressure is required to be within the range (i.e., ≤600psi) of this instrumentation. The uncertainty for RCS pressure above 600psi was assumed to be that associated with the wide range instrumentation.

3/4.4.9 PRESSURE/TEMPERATURE LIMITS (Continued)

Heatup and cooldown limit curves are calculated using the most limiting value of the nil-ductility reference temperature, RT_{NDT}, at the end of 22 effective full power years (EFPY) of service life. The 22 EFPY service life period is chosen such that the limiting RT_{NDT} at the 1/4T location in the core region is greater than the RT_{NDT} of the limiting unirradiated material. The selection of such a limiting RT_{NDT} assures that all components in the Reactor Coolant System will be operated conservatively in accordance with applicable Code requirements.

The reactor vessel materials have been tested to determine their initial RT_{NDT}. Reactor operation and resultant fast neutron (E greater than 1 MeV) irradiation can cause an increase in the RT_{NDT}. Therefore, an adjusted reference temperature, based upon the fluence and chemical content of the material in question, can be predicted. The heatup and cooldown limit curves of Figures 3.4-3, 3.4-4, and 3.4.5 include predicted adjustments for this shift in RT_{NDT}.

Allowable pressure-temperature relationships for various heatup and cooldown rates are calculated using methods derived from Appendix G in Section III of the ASME Boiler and Pressure Vessel Code as required by Appendix G to 10 CFR Part 50. XI

The general method for calculating heatup and cooldown limit curves is based upon the principles of the linear elastic fracture mechanics (LEFM) technology. In the calculation procedures a semielliptical surface defect with a depth of one-quarter of the wall thickness, T, and a length of 3/2T is assumed to exist at the inside of the vessel wall as well as at the outside of the vessel wall. The dimensions of this postulated crack, referred to in Appendix G of ASME Section III as the reference flaw, amply exceed the current capability of inservice inspection techniques. Therefore, the reactor operation limit curves developed for this reference crack are conservative and provide sufficient safety margins for protection against nonductile failure. To assure that the radiation embrittlement effects are accounted for in the calculation of the limit curves, the most limiting value of the nil-ductility reference temperature, RT_{NDT}, is used and this includes the radiation-induced shift, delta RT_{NDT}, corresponding to the end of the period for which heatup and cooldown curves are generated.

The ASME approach for calculating the allowable limit curves for various heatup and cooldown rates specifies that the total stress intensity factor, K_I, for the combined thermal and pressure stresses at any time during heatup or cooldown cannot be greater than the reference stress intensity factor, K_{IR}, for the metal temperature at that time. K_{IR} is obtained from the reference fracture toughness curve, defined in Appendix G to the ASME Code. The K_{IR} is given by the equation:

$$K_{IR} = 26.78 + 1.223 \exp (0.0145(T-RT_{NDT} + 160)) \quad (1)$$

Where: K_{IR} is the reference stress intensity factor as a function of the metal temperature T and the metal nil-ductility reference temperature RT_{NDT}.

3/4.4.9 PRESSURE/TEMPERATURE LIMITS (Continued)

Thus, the governing equation for the heatup-cooldown analysis is defined in Appendix G of the ASME Code as follows:

$$C\,K_{IM} + K_{It} \quad \text{less than or equal to } K_{IR} \qquad (2)$$

Where: K_{IM} = the stress intensity factor caused by membrane (pressure) stress,

K_{It} = the stress intensity factor caused by the thermal gradients,

K_{IR} = ~~constant~~ THE STRESS INTENSITY FACTOR provided by the Code as a function of temperature relative to the RT_{NDT} of the material,

C = 2.0 for level A and B service limits, and

C = 1.5 for inservice hydrostatic and leak test operations.

At any time during the heatup or cooldown transient, K_{IR} is determined by the metal temperature at the tip of the postulated flaw, the appropriate value for RT_{NDT}, and the reference fracture toughness curve. The thermal stresses resulting from temperature gradients through the vessel wall are calculated and then the corresponding thermal stress intensity factor, K_{It}, for the reference flaw is computed. From Equation (2) the pressure stress intensity factors are obtained and, from these, the allowable pressures are calculated.

COOLDOWN

For the calculation of the allowable pressure versus coolant temperature during cooldown, the Code reference flaw is assumed to exist at the inside of the vessel wall. During cooldown, the controlling location of the flaw is always at the inside of the wall because the thermal gradients produce tensile stresses at the inside, which increase with increasing cooldown rates. Allowable pressure-temperature relations are generated for both steady-state and finite cooldown rate situations. From these relations, composite limit curves are constructed for each cooldown rate of interest.

The use of the composite curve in the cooldown analysis is necessary because control of the cooldown procedure is based on measurement of reactor coolant temperature, whereas the limiting pressure is actually dependent on the material temperature at the tip of the assumed flaw. During cooldown, the 1/4T vessel location is at a higher temperature than the fluid adjacent to the vessel ID. This condition, of course, is not true for the steady-state situation. It follows that at any given reactor coolant temperature, the delta T developed during cooldown results in a higher value of K_{IR} at the 1/4T location for finite cooldown rates than for steady-state operation. Furthermore, if conditions exist such that the increase in K_{IR} exceeds K_{It}, the calculated allowable pressure during cooldown will be greater than the steady-state value.

Docket No. 50-213
B14779

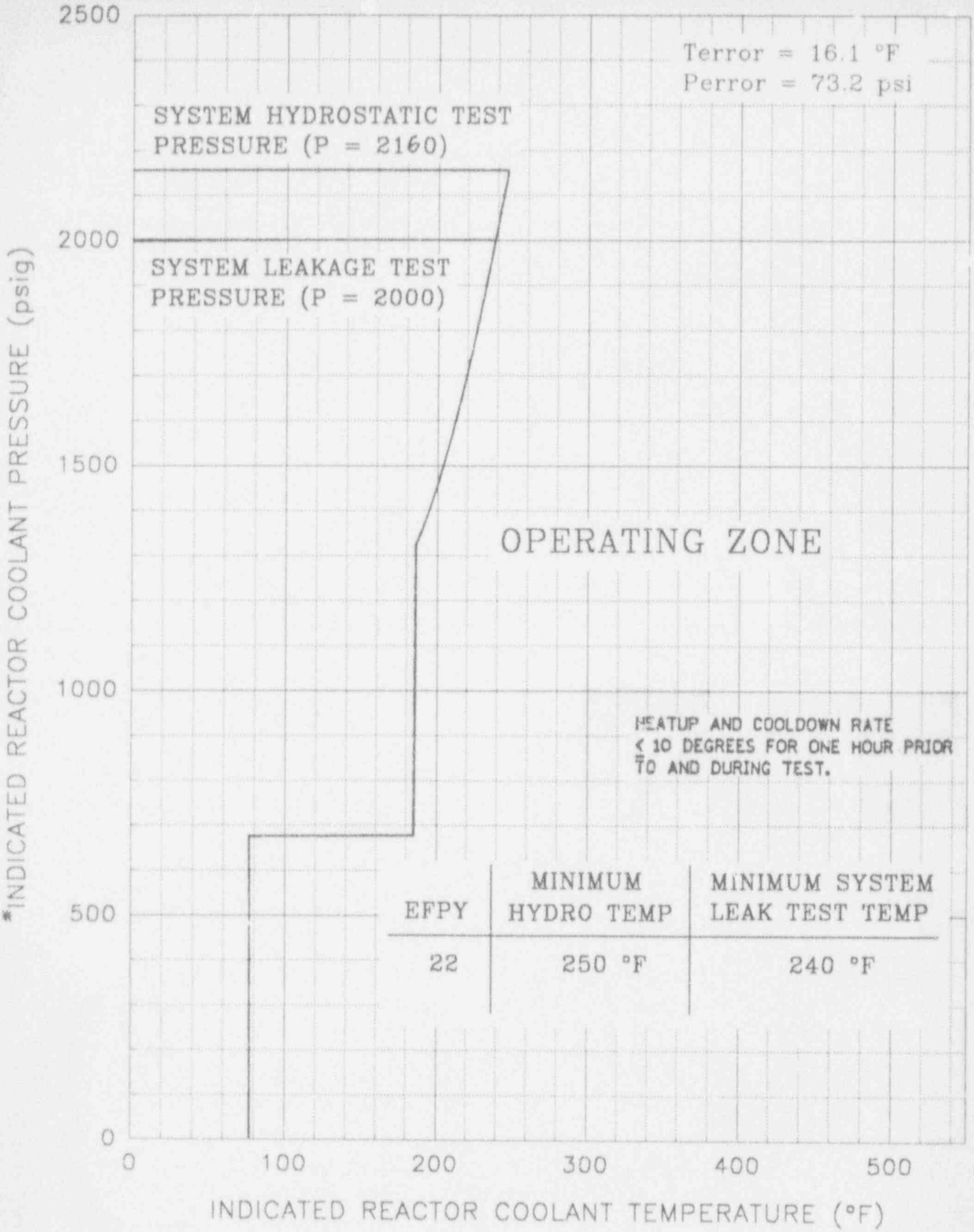
Attachment 2

Haddam Neck Plant

Proposed Revision to Technical Specifications

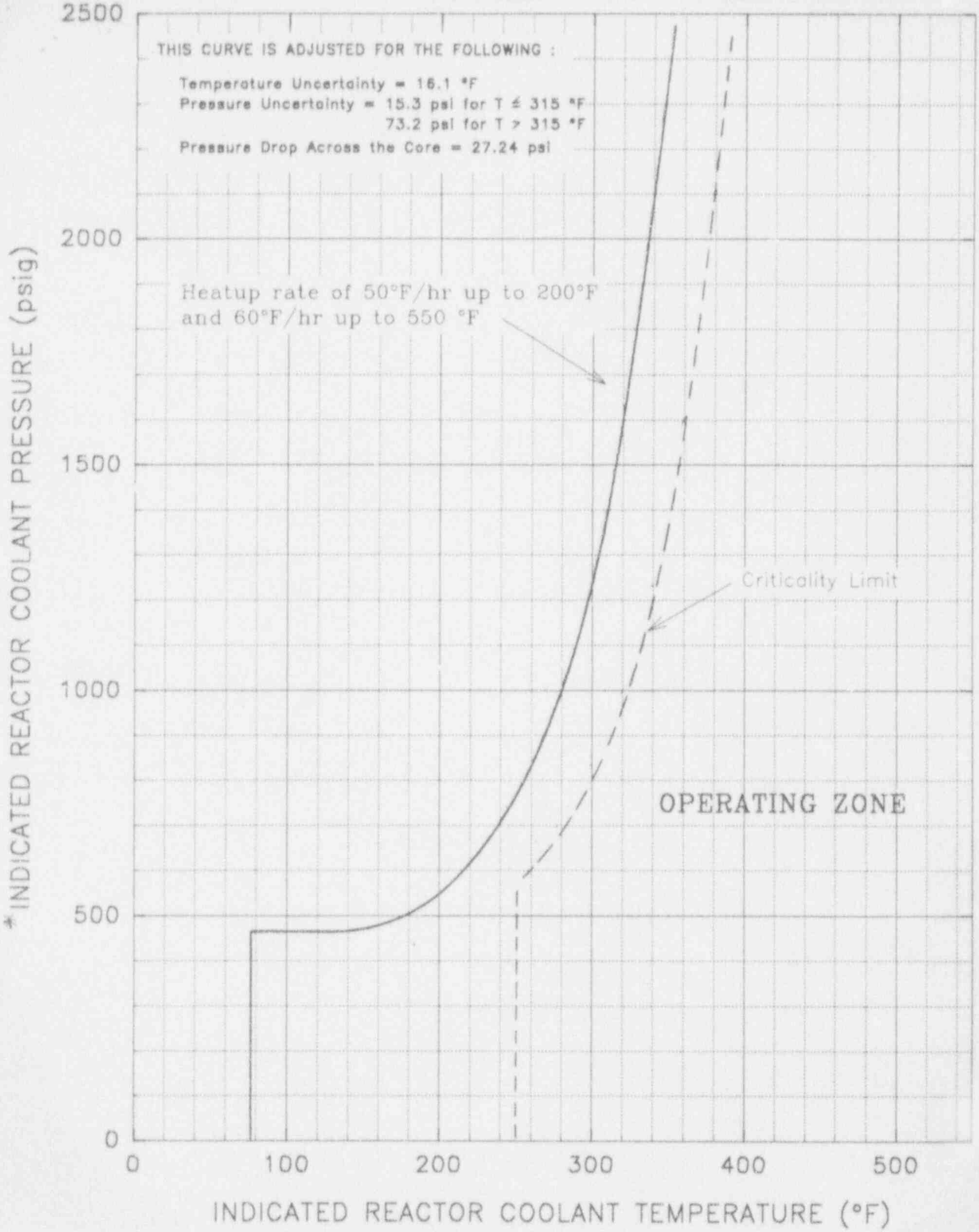
Pressure Temperature Limits - Retyped Pages

April 1994



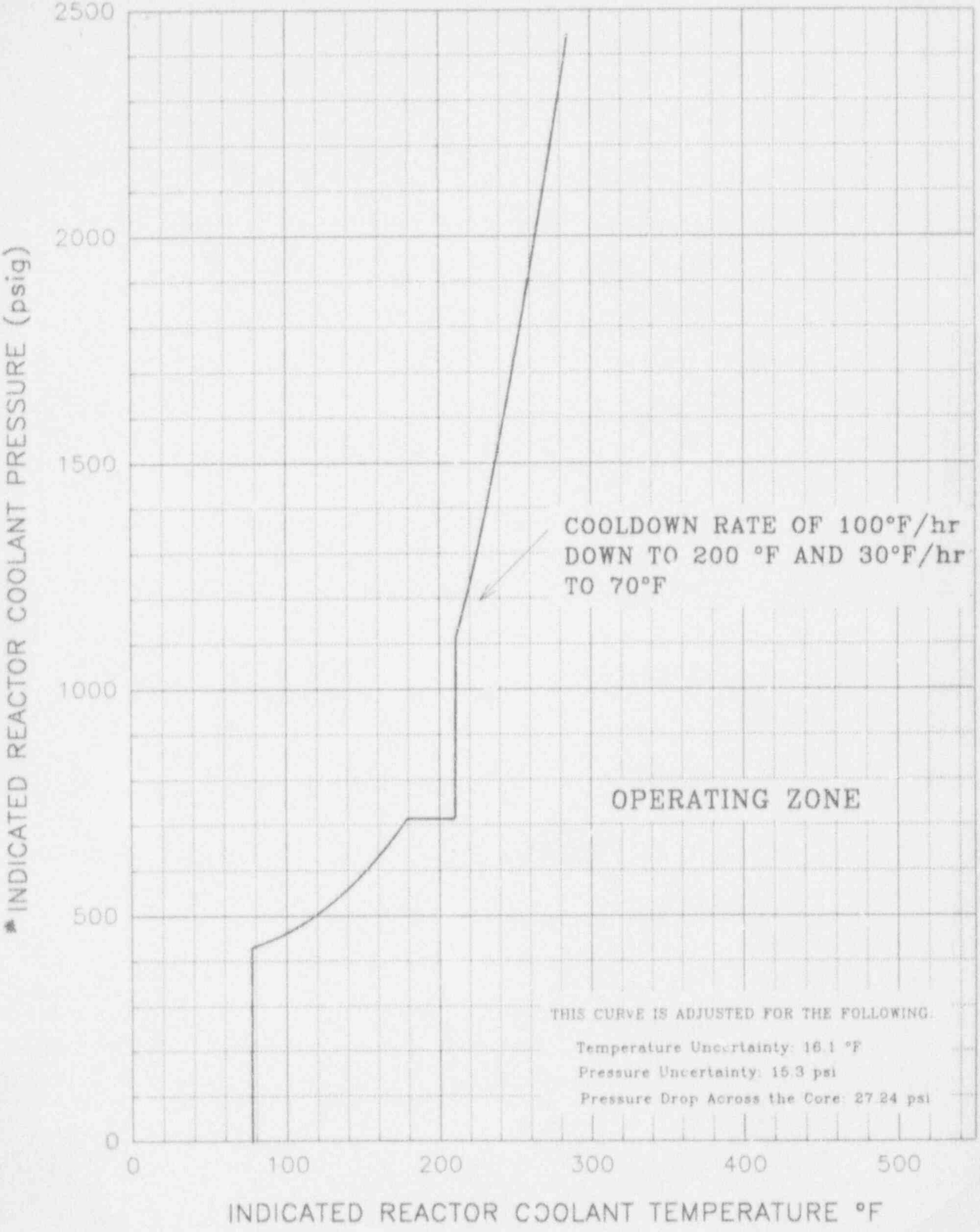
*AS INDICATED BY THE WIDE RANGE PRESSURE TRANSMITTERS

FIGURE 3.4-3
HADDAM NECK LIMIT CURVE FOR HYDROSTATIC AND
LEAK TESTING FOR 22 EFFECTIVE FULL POWER YEARS



*AS INDICATED BY THE NARROW RANGE PRESSURE TRANSMITTER FOR T ≤ 315°F AND THE WIDE RANGE FOR T > 315°F

FIGURE 3.4-4
HADDAM NECK REACTOR COOLANT SYSTEM HEATUP LIMITATIONS FOR 22 EFFECTIVE FULL POWER YEARS



*AS INDICATED BY THE NARROW RANGE PRESSURE TRANSMITTERS

FIGURE 3.4-5
HADDAM NECK REACTOR COOLANT SYSTEM COOLDOWN
LIMITATIONS FOR 22 EFFECTIVE FULL POWER YEARS

3/4.4.8 SPECIFIC ACTIVITY (Continued)

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3/4.4.9 PRESSURE/TEMPERATURE LIMITS (Continued)

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K_{IR} = the stress intensity factor provided by the Code as a function of temperature relative to the RT_{NDT} of the material,

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