WESTINGHOUSE PROPRIETARY CLASS 3

WCAP-13406

# HEATUP AND COOLDOWN LIMIT CURVES FOR NORMAL OPERATION FOR ZION UNITS 1 & 2

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CON'T)

## 1. INTRODUCTION

Heatup and cooldown limit curves are calculated using the most limiting value of $RT_{NDT}$ (reference nil-ductility temperature) for the reactor vessel. The most limiting $RT_{NDT}$ of the material in the core region of the reactor vessel is determined by using the preservice reactor vessel material fracture toughness properties and estimating the radiation-induced $\Delta RT_{NDT}$. $RT_{NDT}$ is designated as the higher of either the drop weight nil-ductility transition temperature (NDTT) or the temperature at which the material exhibits at least 50 ft-lb of impact energy and 35-mil lateral expansion (normal to the major working direction) minus 60°F.

$RT_{NDT}$ increases as the material is exposed to fast-neutron radiation. Therefore, to find the most limiting $RT_{NDT}$ at any time period in the reactor's life, $\Delta RT_{NDT}$ due to the radiation exposure associated with that time period must be added to the original unirradiated $RT_{NDT}$. The extent of the shift in $RT_{NDT}$ is enhanced by certain chemical elements (such as copper and nickel) present in reactor vessel steels. The Nuclear Regulatory Commission (NRC) has published a method for predicting radiation embrittlement in Regulatory Guide 1.99 Rev. 2 (Radiation Embrittlement of Reactor Vessel Materials)[1]. Regulatory Guide 1.99, Revision 2 is used for the calculation of $RT_{NDT}$ values at 1/4T and 3/4T locations (T is the thickness of the vessel at the beltline region).

Recently, new materials data has been obtained from the Babcock and Wilcox (B&W) Integrated Surveillance Capsule Program applicable to both Zion Units 1 and 2. Thus, a new evaluation using this data to determine the most limiting material in the beltline region and the corresponding $RT_{NDT}$ values at 1/4T and 3/4T has been performed. This report summarizes the results of this evaluation and presents the new heatup and cooldown curves generated based on the results of this evaluation.

## LOCATION AND IDENTIFICATION OF BELTLINE REGION MATERIALS

The beltline region is defined to be "the region of the reactor vessel (shell material including welds, heat-affected zones, and plates or forgings) that directly surrounds the effective height of the active core and adjacent regions of the reactor vessel that are predicted to experience sufficient neutron irradiation damage"[2]. Figures 1 and 2 identify the location of all beltline region materials for Zion Units 1 and 2, respectively.

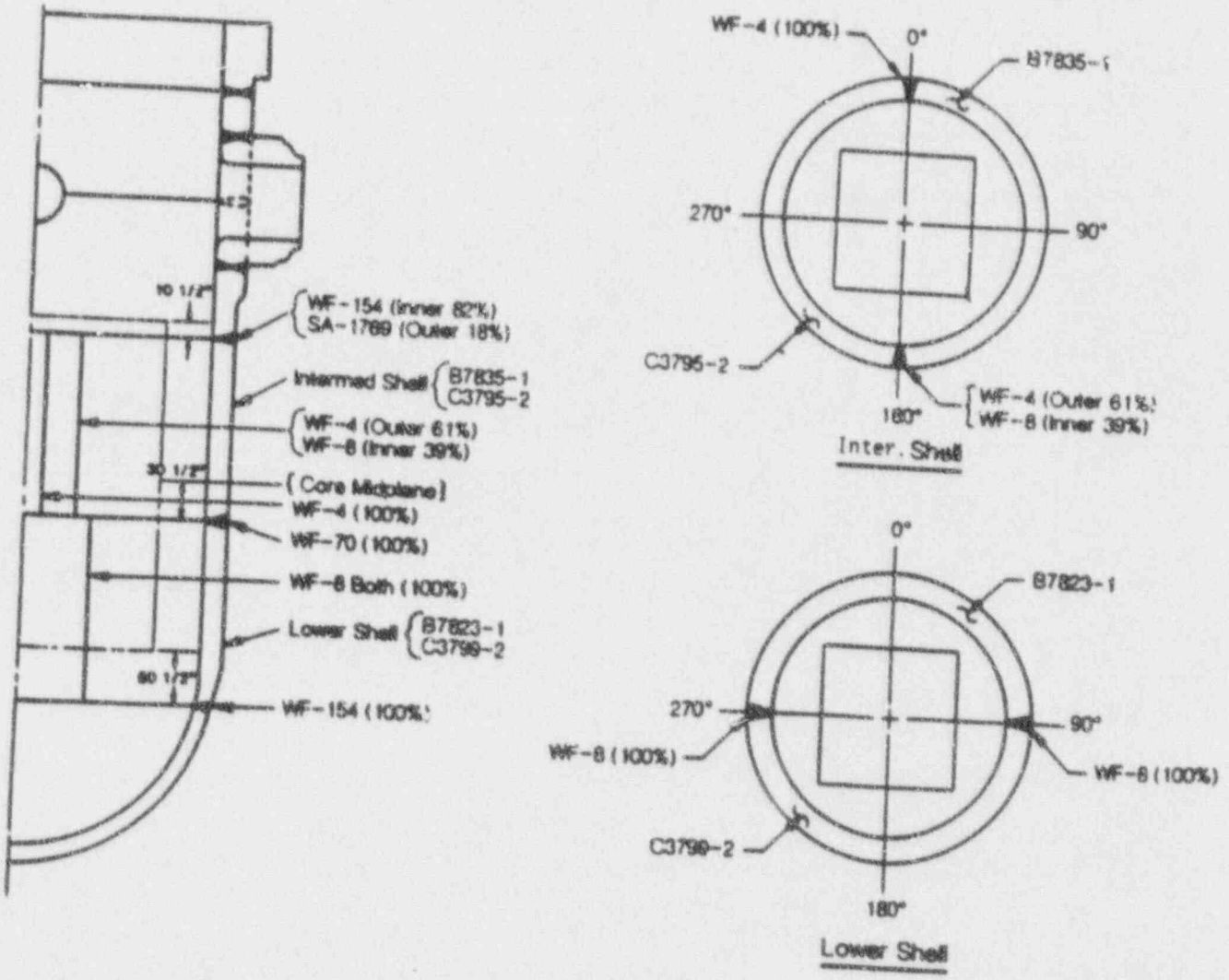


Figure 1. Location and Identification of Materials Used in the Fabrication of Zion Unit 1 Reactor Pressure Vessel

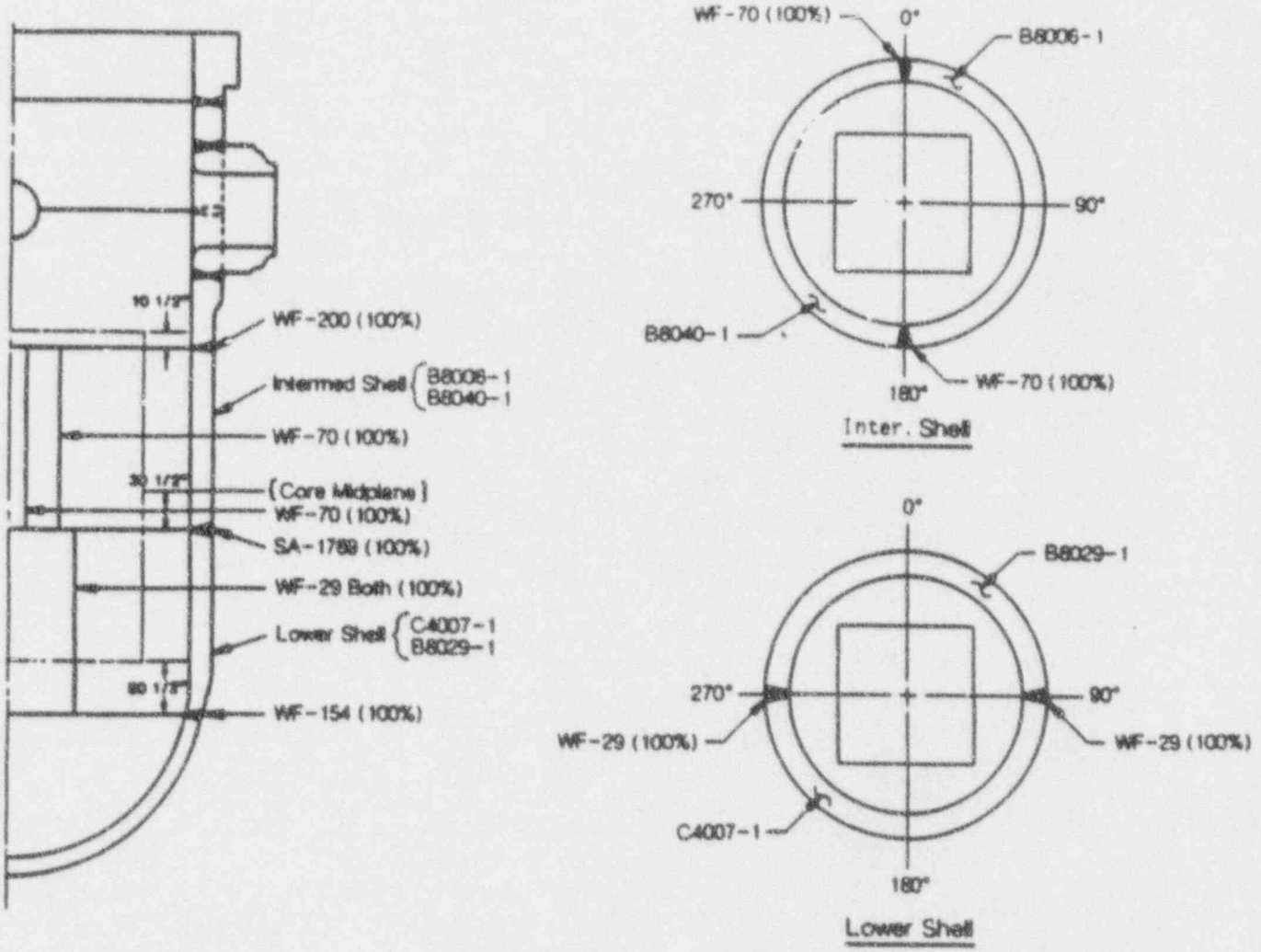


Figure 2. Location and identification of Materials Used in the Fabrication of Zion Unit 2 Reactor Pressure Vessel.

## 3. DEFINITION AND SOURCE OF MATERIAL PROPERTIES FOR ALL VESSEL LOCATIONS

Fast neutron irradiation-induced changes in the tension, fracture, and impact properties of reactor vessel materials are largely dependent on chemical composition, particularly in the copper concentration. The variability in irradiation-induced property changes, which exists in general, is compounded by the variability of copper concentration within the weldments.

In order to address the variation in chemistry, Babcock and Wilcox has given Commonwealth Edison new materials data for Zion Units 1 and 2. The new material data applicable to Zion Units 1 and 2 is shown in Table 1 and was transmitted to Westinghouse via letter dated May 21, 1992, written by Commonwealth Edison Materials Group[3]. This new material data was used to determine the limiting beltline material bounding both Zion Units 1 and 2 and was consequently used to generate the heatup and cooldown limit curves bounding both plants.

## 4. FRACTURE TOUGHNESS PROPERTIES

The fracture-toughness properties of the ferritic material in the reactor coolant pressure boundary are determined in accordance with the NRC Regulatory Standard Review Plan[4]. The pre-irradiation fracture toughness properties for the Zion Units 1 and 2 reactor vessel materials are presented in Tables 2 and 3, respectively.

TABLE 1

MATERIALS DATA FROM B&W INTEGRATED SURVEILLANCE CAPSULE PROGRAM[3]

USED IN DEVELOPING ZION UNITS 1 AND 2 HEATUP AND COOLDOWN CURVES

| Weld Metal | Initial $RT_{NDT}$ (°F) | $\sigma_I$ | $\sigma_\Delta$ * | Chemistry Factor | Copper | Nickel |
|---|---|---|---|---|---|---|
| WF-70 | +18 (2) | 20 (2) | 14 | 174 (2) | .35 (2) | .59 (2) |
| WF-200 | - 5 (1) | 20 (1) | 14 | 162 (3) | .24 (1) | .63 (1) |
| SA-1769 | - 5 (1) | 20 (1) | 14 | 195 (3) | .26 (1) | .61 (1) |
| WF-154 | - 5 (1) | 20 (1) | 14 | 176 (3) | .31 (1) | .59 (1) |

(1) BAW-1803, Rev. 1, "Correlations for Predicting the Effects of Neutron Radiation on Linde 80 Submerged Arc Welds", May 1991.

(2) R.J. Tamminga et al to T.J. Kovach, "Zion Station Units 1 and 2 Revised Initial $RT_{NDT}$ and $RT_{PTS}$ Values for Reactor Pressure Vessel Limting Weld Metal WF-70", Chron #185582, May 11, 1992.

(3) T.L. Baldwin to A.G. Panagos, "Task 145, Report of $RT_{NDT}$ Values for Zion Units 1 and 2 for 15 EFPY", Babcock and Wilcox letter ESC-421, May 14, 1992.

* Per Reg. Guide 1.99, Rev. 2, Position 2, the 28°F $\sigma_\Delta$ value may be divided by 2 because credible surveillance data exists.

TABLE 2 : ZION UNIT 1 REACTOR VESSEL TOUGHNESS DATA (UNIIRADIATED)

| COMPONENT | HEAT NO. | MATERIAL TYPE | Cu (%) | Ni (%) | P (%) | $T_{NDT}$ (°F) | 50 FT-LB/35 MIL TEMP.[a] (°F) | $RT_{NDT}$ (°F) | TRANS[a] USE (FT-LB) |
|---|---|---|---|---|---|---|---|---|---|
| CLOSURE HEAD DOME | B9094-2 | A533B, CL. 1 | .14 | .55 | .012 | 20 | 90 | 30 | 77 |
| CLOSURE HEAD SEG. | C5086-1 | " " | .09 | .54 | .014 | 10 | 32 | 10 | 103 |
| CLOSURE HEAD SEG. | B8793-3 | " " | .09 | .52 | .012 | 10 | 53 | 10 | 96 |
| CLOSURE HEAD FLANGE | 123W323 | A508, CL. 2 | - | .69 | .010 | 55[a] | 26 | 55 | 96 |
| VESSEL FLANGE | 123V236 | " " | .06 | .68 | .004 | 7[a] | -2 | 7 | 131 |
| INLET NOZZLE | ZT3600-1 | " " | .12 | .68 | .009 | 60[a] | 27 | 60 | 79 |
| INLET NOZZLE | ZT3600-2 | " " | .11 | .67 | .009 | 60[a] | 41 | 60 | 82 |
| INLET NOZZLE | ZT3592-1 | " " | .10 | .66 | .011 | 60[a] | 103 | 60 | 77 |
| INLET NOZZLE | ZT3592-2 | " " | .11 | .67 | .010 | 60[a] | 51 | 60 | 62 |
| OUTLET NOZZLE | ZT3592-3 | " " | .11 | .68 | .010 | 60[a] | 60 | 60 | 86 |
| OUTLET NOZZLE | ZT3592-4 | " " | .11 | .68 | .009 | 46[a] | 16 | 46 | 85 |
| OUTLET NOZZLE | ZT3600-3 | " " | .10 | .67 | .011 | 60[a] | 52 | 60 | 62 |
| OUTLET NOZZLE | ZT3600-4 | " " | .11 | .68 | .011 | 60[a] | 46 | 60 | >63 |
| UPPER NOZZLE SHELL | 123V426 | " " | .06 | .75 | .005 | 10 | 43 | 10 | 115 |
| LOWER NOZZLE SHELL | ZV3300 | " " | .06 | .83 | .008 | 20 | 72 | 20 | 87 |
| INTER. SHELL | C3795-2 | A533B, CL. 1 | .12 | .49 | .010 | -10 | 70 | 10 | 85 |
| INTER. SHELL | B7835-1 | " " | .12 | .49 | .010 | -20 | 65 (Actual) | 5 | 115 (Actual) |
| LOWER SHELL | B7823-1 | " " | .13 | .48 | .013 | -20 | 56 (Actual) | -4 | 115.5 (Actual) |
| LOWER SHELL | C3799-2 | " " | .15 | .50 | .010 | -20 | 80 (Actual) | 20 | 116 (Actual) |
| BOTTOM HEAD TRANS. RING | ZV3779 | A508, CL. 2 | .09 | .71 | .010 | 10 | 60 | 10 | 92 |
| BOTTOM HEAD DOME | B7777-1 | A533B, CL. 1 | - | .62 | .015 | -30 | 33 | -27 | 84 |
| INTER. TO LOWER SHELL GIRTH WELD SEAM | WF70[b] | SAW | .32 | .56 | .017 | 0[a] | - | 0 | - |
| INTER. SHELL LONG. WELD SEAM | WF4[c] | SAW | .29 | .55 | .013 | 0[a] | - | 0 | - |
| INTER. SHELL LONG. WELD SEAM | WF8[d] | SAW | .29 | .55 | .013 | 0[a] | - | 0 | - |
| LOWER SHELL LONG. WELD SEAM | WF8[d] | SAW | .29 | .55 | .013 | 0[a] | - | 0 | - |

(a) ESTIMATED USING METHODS OF U.S.NRC NUREG-0800, BRANCH TECHNICAL POSITION MTEB 5-2, JULY, 1981

(b) WELD WIRE HEAT NO. 72105 AND LINDE 80 FLUX LOT NO. 8669

(c) WELD WIRE HEAT NO. BT1762 AND LINDE 80 FLUX LOT NO. 8597

(d) WELD WIRE HEAT NO. BT1762 AND LINDE 80 FLUX LOT NO. 8632

TABLE 3 : ZION UNIT 2 REACTOR VESSEL TOUGHNESS DATA (UNIRRADIATED)

| COMPONENT | HEAT NO. | MATERIAL TYPE | Cu (%) | Ni (%) | P (%) | $T_{NDT}$ (°F) | 50 FT-LB/35 MIL TEMP.[a] (°F) | $RT_{NDT}$ (°F) | TRANS[a] USE (FT-LB) |
|---|---|---|---|---|---|---|---|---|---|
| CLOSURE HEAD DOME | B9094-1 | A533B, CL. 1 | .14 | .55 | .012 | -20 | 71 | 11 | 72 |
| CLOSURE HEAD SEG. | C4787-1A | " " | .13 | .62 | .008 | 0 | 30 | 0 | 88 |
| CLOSURE HEAD SEG. | C5086-2 | " " | .09 | .54 | .014 | 30 | 45 | 30 | 88 |
| CLOSURE HEAD FLANGE | 124N609 | A508, CL. 2 | .08 | .70 | .010 | 12[a] | -13 | 12 | 105 |
| VESSEL FLANGE | ZV-965 | " " | .12 | .74 | .010 | 60[a] | 33 | 60 | 79 |
| INLET NOZZLE | ZT4007-2 | " " | .11 | .70 | .009 | 48[a] | 32 | 48 | >78 |
| INLET NOZZLE | ZT3885-1 | " " | .11 | .58 | .012 | 60[a] | 43 | 60 | 82 |
| INLET NOZZLE | ZT3885 | " " | .11 | .56 | .011 | 43[a] | 31 | 43 | 78 |
| INLET NOZZLE | ZT3885 | " " | .11 | .56 | .012 | 60[a] | 48 | 60 | >84 |
| OUTLET NOZZLE | ZV3930 | " " | .12 | .66 | .010 | 58[a] | 20 | 58 | 93 |
| OUTLET NOZZLE | ZV3930 | " " | .11 | .65 | .011 | 48[a] | 15 | 48 | >80 |
| OUTLET NOZZLE | ZV3930 | " " | .12 | .67 | .011 | 55[a] | 28 | 55 | 84 |
| OUTLET NOZZLE | ZT3885-4 | " " | .11 | .57 | .013 | 60[a] | 41 | 60 | > 61 |
| UPPER NOZZLE SHELL | ZD3940 | A508, CL. 2 | .07 | .62 | .008 | 10 | 65 | 10 | 106 |
| LOWER NOZZLE SHELL | ZV3855 | " " | .09 | .66 | .008 | 10 | 70 | 10 | >80 |
| INTER. SHELL | B8029-1 | A533B, CL. 1 | .12 | .51 | .010 | -10 | 82 | 22 | 81 |
| INTER. SHELL | C4007-1 | " " | .12 | .53 | .010 | 10 | 82 (Actual) | 22 | 94 (Actual) |
| LOWER SHELL | B8006-1 | " " | .12 | .54 | .010 | 10 | 68 | 10 | 89 |
| LOWER SHELL | B8040-1 | " " | .14 | .52 | .008 | -10 | 62 | 2 | 92 |
| BOTTOM HEAD TRANS. RING | 3V-433 | A508, CL. 2 | .09 | .78 | .010 | 0 | 43 | 0 | 87 |
| BOTTOM HEAD DOME | C4007-2 | A533B, CL. 1 | .12 | .53 | .010 | -20 | 60 | 0 | 72 |
| INTER. TO LOWER SHELL GIRTH WELD SEAM | SA1769[b] | SAW | .26 | .60 | .019 | 0[a] | - | 0 | - |
| INTER. SHELL LONG. WELD SEAMS | WF29[c] | SAW | .23 | .63 | .019 | 0[a] | - | 0 | - |
| LOWER SHELL LONG. WELD SEAMS | WF70[d] | SAW | .32 | .56 | .017 | 0[a] | - | 0 | - |

(a) ESTIMATED USING METHOD OF U.S.NRC NUREG-0800 BRANCH TECHNICAL POSITION MTEB 5-2, JULY, 1981

(b) WELD WIRE HEAT NO. 71249 AND LINDE 80 FLUX LOT NO. 8738

(c) WELD WIRE HEAT NO. 72102 AND LINDE 80 FLUX LOT NO. 8650

(d) WELD WIRE HEAT NO. 72105 AND LINDE 80 FLUX LOT NO. 8669

## 5. CRITERIA FOR ALLOWABLE PRESSURE-TEMPERATURE RELATIONSHIPS

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[5]. The $K_{IR}$ curve is given by the following equation:

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

where

$K_{IR}$ = reference stress intensity factor as a function of the metal temperature T and the metal reference nil-ductility temperature $RT_{NDT}$

Therefore, the governing equation for the heatup-cooldown analysis is defined in Appendix G of the ASME Code[5] as follows:

$$C*K_{IM} + K_{IT} \leq K_{IR} \quad (2)$$

where

$K_{IM}$ = stress intensity factor caused by membrane (pressure) stress

$K_{IT}$ = stress intensity factor caused by the thermal gradients

$K_{IR}$ = function of temperature relative to the $RT_{NDT}$ of the material

C = 2.0 for Level A and Level B service limits

C = 1.5 for hydrostatic and leak test conditions during which the reactor core is not critical

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 the temperature gradients through the vessel wall are calculated and then the corresponding (thermal) stress intensity factors, $K_{IT}$, for the reference flaw are computed. From equation 2, the pressure stress intensity factors are obtained and from these the allowable pressures are calculated.

For the calculation of the allowable pressure versus coolant temperature during cooldown, the reference flaw of Appendix G to the ASME Code 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 the 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 1/4 T 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 1/4 T location for finite cooldown rates than for steady-state operation. Furthermore, if conditions exist so that the increase in $K_{IR}$ exceeds $K_{IT}$, the calculated allowable pressure during cooldown will be greater than the steady-state value.

The above procedures are needed because there is no direct control on temperature at the 1/4 T location and, therefore, allowable pressures may unknowingly be violated if the rate of cooling is decreased at various intervals along a cooldown ramp. The use of the composite curve eliminates this problem and ensures conservative operation of the system for the entire cooldown period.

Three separate calculations are required to determine the limit curves for finite heatup rates. As is done in the cooldown analysis, allowable pressure-temperature relationships are developed for steady-state conditions as well as finite heatup rate conditions assuming the presence of a 1/4 T defect at the inside of the wall that alleviate the tensile stresses produced by internal pressure. The metal temperature at the crack tip lags the coolant temperature; therefore, the $K_{IR}$ for the 1/4 T crack during heatup is lower than the $K_{IR}$ for the 1/4 T crack during steady-state conditions at the same coolant temperature. During heatup, especially at the end of the transient, conditions may exist so that the effects of compressive thermal stresses and lower $K_{IR}$'s do not offset each other, and the pressure- temperature curve based on steady-state conditions no longer represents a lower bound of all similar curves for finite heatup rates when the 1/4 T flaw is considered. Therefore, both cases have to be analyzed in order to ensure that at any coolant temperature the lower value of the allowable pressure calculated for steady-state and finite heatup rates is obtained.

The second portion of the heatup analysis concerns the calculation of the pressure-temperature limitations for the case in which a 1/4 T deep outside surface flaw is assumed. Unlike the situation at the vessel inside surface, the thermal gradients established at the outside surface during heatup produce stresses which are tensile in nature and therefore tend to reinforce any pressure stresses present. These thermal stresses are dependent on both the rate of heatup and the time (or coolant temperature) along the heatup ramp. Since the thermal stresses at the outside are tensile and increase with increasing heatup rates, each heatup rate must be analyzed on an individual basis.

Following the generation of pressure-temperature curves for both the steady-state and finite heatup rate situations, the final limit curves are produced by constructing a composite curve based on a point-by-point comparison of the steady-state and finite heatup rate data. At any given temperature, the allowable pressure is taken to be the lesser of the three values taken from the curves under consideration. The use of the composite curve is necessary to set conservative heatup limitations because it is possible for conditions to exist wherein, over the course of the heatup ramp, the controlling condition switches from the inside to the outside, and the pressure limit must at all times be based on analysis of the most critical criterion.

Finally, the 1983 Amendment to 10CFR50 Appendix G[2] has a rule which addresses the metal temperature of the closure head flange and vessel flange regions. This rule states that the metal temperature of the closure flange regions must exceed the material $RT_{NDT}$ by at least 120°F for normal operation when the pressure exceeds 20 percent of the preservice hydrostatic test pressure (621 psig for Zion Units 1 and 2).

The minimum allowable temperature is based upon the limiting initial $RT_{NDT}$ in the vessel and closure flange regions of Zion Units 1 and 2. Table 2 indicates that the initial $RT_{NDT}$ of 55°F and 7°F occurs in the closure head flange and vessel flange, respectively, of Zion Unit 1 reactor vessel. Table 3 indicates that the initial $RT_{NDT}$ of 12°F and 60°F occurs in the closure head flange and vessel flange, respectively, of Zion Unit 2 reactor vessel. Therefore, using the most limiting initial $RT_{NDT}$ value of 60°F, bounding Zion Units 1 and 2, the minimum allowable temperature of this region s determined to be 180°F at pressures greater than 621 psig. These limits are less restrictive than the limits shown in Figures 3 through 22.

## 6. HEATUP AND COOLDOWN PRESSURE-TEMPERATURE LIMIT CURVES

Pressure-temperature limit curves for normal heatup and cooldown of the Reactor Coolant System have been calculated using the methods discussed in Section 5. Figures 3 through 18 contain the heatup curves for 20, 40, 60 and 100 °F/hr for 14, 20, 25 and 32 EFPY, respectively, applicable to both Zion Units 1 and 2. Figures 19 through 22 contain the cooldown curves up to 100°F/hr for 14, 20, 25 and 32 EFPY, respectively, applicable to both Zion Units 1 and 2. Margins of 10 °F and 60 psig are included in these figures to allow for possible instrumentation errors.

Allowable combinations of temperature and pressure for specific temperature change rates are below and to the right of the limit lines shown in Figures 3 through 22. This is in addition to other criteria which must be met before the reactor is made critical.

The leak limit curves shown in Figures 3 through 22 represent the minimum temperature requirements at the leak test pressure specified by applicable codes[4, 5]. The leak test limit curve was determined by methods described in 10CFR50 Appendix G[2] and the Standard Review Plan[4].

The criticality limit curves shown in Figures 3 through 22, specify pressure-temperature limits for critical core operation to provide additional margin during actual power production as specified in 10CFR50 Appendix G[2]. The pressure- temperature limits for core operation (except for low power physics tests) are that the reactor vessel must be at a temperature equal to or higher than the minimum temperature required for the inservice hydrostatic test, and at least 40°F higher than the minimum pressure-temperature curve for heatup and cooldown calculated as described in Section 3. The maximum temperature for the inservice hydrostatic leak test bounding Zion Units 1 and 2 reactor vessels is 352°F, 367°F, 377°F, and 389°F for 14, 20, 25 and 32 EFPY, respectively. A vertical line at these temperatures on the pressure-temperature curve for 14, 20, 25 and 32 EFPY, respectively, intersecting a curve 40°F higher than the pressure-temperature limit curve, constitutes the limit for core operation for the reactor vessel.

Figures 3 through 22 define limits for ensuring prevention of nonductile failure for Zion Units 1 and 2 reactor vessels.

## 7. CALCULATION OF ADJUSTED REFERENCE TEMPERATURE

From Regulatory Guide 1.99 Rev. 2[1], the adjusted reference temperature (ART) for each material in the beltline is given by the following expression:

$$ART = \text{Initial } RT_{NDT} + \Delta RT_{NDT} + \text{Margin} \qquad (3)$$

Initial $RT_{NDT}$ is the reference temperature for the unirradiated material as defined in paragraph NB-2331 of Section III of the ASME Boiler and Pressure Vessel Code. If measured values of initial $RT_{NDT}$ for the material in question are not available, generic mean values for that class of material may be used if there are sufficient test results to establish a mean and standard deviation for the class.

$\Delta RT_{NDT}$ is the mean value of the adjustment in reference temperature caused by irradiation and should be calculated as follows:

$$\Delta RT_{NDT} = [CF]f^{(0.28-0.10 \log f)} \quad (4)$$

To calculate $\Delta RT_{NDT}$ at any depth (e.g., at 1/4T or 3/4T), the following formula must first be used to attenuate the fluence at the specific depth.

$$f_{(\text{depth } X)} = f_{surface}(e^{-.24x}) \quad (5)$$

where x (in inches) is the depth into the vessel wall measured from the vessel clad/base metal interface. The resultant fluence is then put into equation (4) to calculate $\Delta RT_{NDT}$ at the specific depth.

CF (°F) is the chemistry factor, a function of Copper and Nickel content. Chemistry factor values for the welds were obtained from the B&W Integrated Surveillance Capsule Program per letter from Commonwealth Edison[3]. These values are shown in Table 1. Chemistry factor values for the base metals (plates and forgings) were obtained from Table 2 in Regulatory Guide 1.99, Revision 2[1], using the corresponding Copper and Nickel content for each material.

Applying the methodology described in Regulatory Guide 1.99, Revision 2[1] to determine the Adjusted Reference Temperature (ART) for each beltline region material, it was found that the circumferential weld seam WF-70 in Zion Unit 1, between the vessel intermediate and lower shell, was the limiting material bounding both Zion Units 1 and 2. ART values for the circumferential weld WF-70 were evaluated at 1/4T and 3/4T locations using chemistry factor values provided by Commonwealth Edison from the B&W Reactor Vessel Integrated Surveillance Capsule Program[3].

The results of the ART values at 1/4T and 3/4T for all materials in the beltline region of Zion Units 1 and 2 are presented in Tables 4 and 5, respectively. Note the ART values shown in Tables 4 and 5 were obtained using chemistry factors from the Regulatory Guide 1.99, Revision 2, tables. The ART values using the new B&W materials data from their Integrated Surveillance Capsule Program are shown in Tables 4 and 5 with an * as a footnote. Sample calculations of adjusted reference temperatures are shown in Tables 6 through 9.

TABLE 4

SUMMARY OF ADJUSTED REFERENCE TEMPERATURES AT 1/4T AND 3/4T LOCATIONS OF ZION UNIT 1 BELTLINE REGION MATERIALS

FOR 14, 20, 25 AND 32 EFPY

| | 14 EFPY | | 20 EFPY | | 25 EFPY | | 32 EFPY | |
|---|---|---|---|---|---|---|---|---|
| | $RT_{NDT}$ AT | | $RT_{NDT}$ AT | | $RT_{NDT}$ AT | | $RT_{NDT}$ AT | |
| Component | 1/4T (°F) | 3/4T (°F) | 1/4T (°F) | 3/4T (°F) | 1/4T (°F) | 3/4T (°F) | 1/4T (°F) | 3/4T (°F) |
| Circ. Weld WF-154/SA-1769 * (Upper to Inter.) | 167 | 125 | 183 | 137 | 193 | 146 | 204 | 156 |
| Inter. Shell B7835-1 | 84 | 64 | 91 | 70 | 96 | 74 | 101 | 79 |
| Inter. Shell C3795-2 | 123 | 102 | 130 | 108 | 135 | 112 | 140 | 117 |
| Long. Weld WF-4 @ 0° | 165 | 127 | 179 | 138 | 189 | 146 | 201 | 155 |
| Long. Weld WF-4/WF-8 @ 180° | 165 | 127 | 179 | 138 | 189 | 146 | 201 | 155 |
| Circ. Weld WF-70 * (Inter. to Lower) | 206 | 161 | 222 | 175 | 232 | 184 | 243 | 194 |
| Lower Shell B7823-1 | 100 | 77 | 108 | 84 | 113 | 89 | 118 | 94 |
| Lower Shell C3799-2 | 138 | 111 | 147 | 119 | 153 | 124 | 160 | 130 |
| Long. Weld WF-8 @ 90° | 165 | 127 | 180 | 138 | 189 | 146 | 201 | 155 |
| Long. Weld WF-8 @ 270° | 165 | 127 | 180 | 138 | 189 | 146 | 201 | 155 |

* $RT_{NDT}$ values calculated using new materials data from the B&W Integrated Surveillance Capsule Program

TABLE 5

SUMMARY OF ADJUSTED REFERENCE TEMPERATURES AT 1/4T AND 3/4T LOCATIONS OF ZION UNIT 2 BELTLINE REGION MATERIALS

FOR 14, 20, 25 AND 32 EFPY

| | 14 EFPY | | 20 EFPY | | 25 EFPY | | 32 EFPY | |
|---|---|---|---|---|---|---|---|---|
| | $RT_{NDT}$ AT | | $RT_{NDT}$ AT | | $RT_{NDT}$ AT | | $RT_{NDT}$ AT | |
| Component | 1/4T (°F) | 3/4T (°F) | 1/4T (°F) | 3/4T (°F) | 1/4T (°F) | 3/4T (°F) | 1/4T (°F) | 3/4T (°F) |
| Circ. Weld WF-200 * (Upper to Inter.) | 161 | 121 | 175 | 133 | 184 | 141 | 195 | 150 |
| Inter. Shell B8006-1 | 123 | 102 | 130 | 108 | 135 | 112 | 140 | 117 |
| Inter. Shell B8040-1 | 127 | 102 | 135 | 109 | 141 | 114 | 147 | 120 |
| Long. Weld WF-70 @ 0° | 158 | 123 | 172 | 133 | 181 | 141 | 192 | 150 |
| Long. Weld WF-70 @ 180° | 158 | 123 | 172 | 133 | 181 | 141 | 192 | 150 |
| Circ. Weld SA-1769 * (Inter. to Lower) | 199 | 149 | 216 | 164 | 228 | 174 | 240 | 186 |
| Lower Shell C4007-1 | 109 | 86 | 117 | 93 | 122 | 98 | 128 | 103 |
| Lower Shell B8029-1 | 135 | 114 | 142 | 120 | 146 | 124 | 152 | 129 |
| Long. Weld WF-29 @ 90° | 157 | 122 | 171 | 133 | 181 | 140 | 191 | 149 |
| Long. Weld WF-29 @ 270° | 157 | 122 | 171 | 133 | 181 | 140 | 191 | 149 |

* $RT_{NDT}$ values calculated using new materials data from the B&W Integrated Surveillance Capsule Program.

TABLE 6

CALCULATION OF ADJUSTED REFERENCE TEMPERATURES FOR THE LIMITING REACTOR VESSEL MATERIAL BOUNDING ZION UNITS 1 & 2 - CIRC. WELD WF-70 - FOR 14 EFPY

| | Regulatory Guide 1.99 - Revision 2 | |
|---|---|---|
| | 14 EFPY | |
| Parameter | 1/4 T | 3/4 T |
| Chemistry Factor, CF (°F)(a) | 174 | 174 |
| Fluence, f ($10^{19}$ n/cm$^2$)(b) | 0.492 | 0.179 |
| Fluence Factor, ff | 0.802 | 0.543 |
| $\Delta RT_{NDT}$ = CF x ff (°F) | 139 | 94 |
| Initial $RT_{NDT}$, I (°F) | 18 | 18 |
| Margin, M (°F) (c) | 48.8 | 48.8 |
| Revision 2 to Regulatory Guide 1.99 | | |
| Adjusted Reference Temperature, ART = Initial $RT_{NDT}$ + $\Delta RT_{NDT}$ + Margin | 206 | 161 |

(a) Chemistry Factor value was provided by Commonwealth Edison from the B&W Surveillance Capsule Program[3]. See Table 1.

(b) Fluence, f, is based upon $f_{surf}$ ($10^{19}$ n/cm$^2$, E>1 Mev) = 0.8166 at 14 EFPY. The Zion Unit 1 reactor vessel wall thickness is 8.441 inches at the beltline region.

(c) Margin is calculated as, $M = 2\,[\sigma_I^2 + \sigma_\Delta^2]^{0.5}$. The standard deviation for the initial $RT_{NDT}$ margin term ($\sigma_I$) is 20°F. This value was provided by Commonwealth Edison from the B&W Integrated Surveillance Capsule Program[3], also shown in Table 1. The standard deviation for $\Delta RT_{NDT}$, ($\sigma_\Delta$) is 14°F for weld metal, since credible surveillance data exists from the B&W Integrated Surveillance Capsule Program.

TABLE 7

CALCULATION OF ADJUSTED REFERENCE TEMPERATURES FOR THE LIMITING REACTOR VESSEL MATERIAL BOUNDING ZION UNITS 1 & 2 - CIRC. WELD WF-70 - FOR 20 EFPY

| Parameter | Regulatory Guide 1.99 - Revision 2 20 EFPY 1/4 T | 3/4 T |
|---|---|---|
| Chemistry Factor, CF (°F)(a) | 174 | 174 |
| Fluence, f ($10^{19}$ n/cm$^2$)(b) | 0.676 | 0.245 |
| Fluence Factor, ff | 0.890 | 0.619 |
| $\Delta RT_{NDT}$ = CF x ff (°F) | 155 | 108 |
| Initial $RT_{NDT}$, I (°F) | 18 | 18 |
| Margin, M (°F) (c) | 48.8 | 48.8 |
| Revision 2 to Regulatory Guide 1.99 | | |
| Adjusted Reference Temperature, ART = Initial $RT_{NDT}$ + $\Delta RT_{NDT}$ + Margin | 222 | 175 |

(a) Chemistry Factor value was provided by Commonwealth Edison from the B&W Surveillance Capsule Program[3]. see Table 1.

(b) Fluence, f, is based upon $f_{surf}$ ($10^{19}$ n/cm$^2$, E>1 Mev) = 1.121 at 20 EFPY. The Zion Unit 1 reactor vessel wall thickness is 8.441 inches at the beltline region.

(c) Margin is calculated as, $M = 2\ [\sigma_I^2 + \sigma_\Delta^2]^{0.5}$. The standard deviation for the initial $RT_{NDT}$ margin term ($\sigma_I$) is 20°F. This value was provided by Commonwealth Edison from the B&W Integrated Surveillance Capsule Program[3], also shown in Table 1. The standard deviation for $\Delta RT_{NDT}$, ($\sigma_\Delta$) is 14°F for weld metal, since credible surveillance data exists from the B&W Integrated Surveillance Capsule Program.

TABLE 8

CALCULATION OF ADJUSTED REFERENCE TEMPERATURES FOR THE LIMITING REACTOR VESSEL MATERIAL BOUNDING ZION UNITS 1 & 2 - CIRC. WELD WF-70 - FOR 25 EFPY

| | Regulatory Guide 1.99 - Revision 2 | |
|---|---|---|
| | 25 EFPY | |
| Parameter | 1/4 T | 3/4 T |
| Chemistry Factor, CF (°F)(a) | 174 | 174 |
| Fluence, f ($10^{19}$ n/cm$^2$)(b) | 0.829 | 0.301 |
| Fluence Factor, ff | 0.947 | 0.671 |
| $\Delta RT_{NDT}$ = CF x ff (°F) | 165 | 117 |
| Initial $RT_{NDT}$, I (°F) | 18 | 18 |
| Margin, M (°F) (c) | 48.8 | 48.8 |
| Revision 2 to Regulatory Guide 1.99 | | |
| Adjusted Reference Temperature, ART = Initial $RT_{NDT}$ + $\Delta RT_{NDT}$ + Margin | 232 | 184 |

(a) Chemistry Factor value was provided by Commonwealth Edison from the B&W Surveillance Capsule Program[3]. See Table 1.

(b) Fluence, f, is based upon $f_{surf}$ ($10^{19}$ n/cm$^2$, E>1 Mev) = 1.376 at 25 EFPY[6]. The Zion Unit 1 reactor vessel wall thickness is 8.441 inches at the beltline region.

(c) Margin is calculated as, $M = 2\,[\sigma_I^2 + \sigma_\Delta^2]^{0.5}$. The standard deviation for the initial $RT_{NDT}$ margin term ($\sigma_I$) is 20°F. This value was provided by Commonwealth Edison from the B&W Integrated Surveillance Capsule Program[3], also shown in Table 1. The standard deviation for $\Delta RT_{NDT}$, ($\sigma_\Delta$) is 14°F for weld metal, since credible surveillance data exists from the B&W Integrated Surveillance Capsule Program.

TABLE 9

CALCULATION OF ADJUSTED REFERENCE TEMPERATURES FOR THE LIMITING REACTOR VESSEL MATERIAL BOUNDING ZION UNITS 1 & 2 - CIRC. WELD WF-70 - FOR 32 EFPY

| Parameter | Regulatory Guide 1.99 - Revision 2 32 EFPY 1/4 T | 32 EFPY 3/4 T |
|---|---|---|
| Chemistry Factor, CF (°F)(a) | 174 | 174 |
| Fluence, f ($10^{19}$ n/cm$^2$)(b) | 1.044 | 0.379 |
| Fluence Factor, ff | 1.012 | 0.732 |
| $\Delta RT_{NDT}$ = CF x ff (°F) | 176 | 127 |
| Initial $RT_{NDT}$, I (°F) | 18 | 18 |
| Margin, M (°F) (c) | 48.8 | 48.8 |
| Revision 2 to Regulatory Guide 1.99 | | |
| Adjusted Reference Temperature, ART = Initial $RT_{NDT}$ + $\Delta RT_{NDT}$ + Margin | 243 | 194 |

(a) Chemistry Factor value was provided by Commonwealth Edison from the B&W Surveillance Capsule Program[3]. See Table 1.

(b) Fluence, f, is based upon $f_{surf}$ ($10^{19}$ n/cm$^2$, E>1 Mev) = 1.732 at 32 EFPY[6]. The Zion Unit 1 reactor vessel wall thickness is 8.441 inches at the beltline region.

(c) Margin is calculated as, $M = 2\,[\sigma_I^2 + \sigma_\Delta^2]^{0.5}$. The standard deviation for the initial $RT_{NDT}$ margin term ($\sigma_I$) is 20°F. This value was provided by Commonwealth Edison from the B&W Integrated Surveillance Capsule Program[3], also shown in Table 1. The standard deviation for $\Delta RT_{NDT}$, ($\sigma_\Delta$) is 14°F for weld metal, since credible surveillance data exists from the B&W Integrated Surveillance Capsule Program.

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 14 EFPY: 1/4T = 206°F
3/4T = 161°F

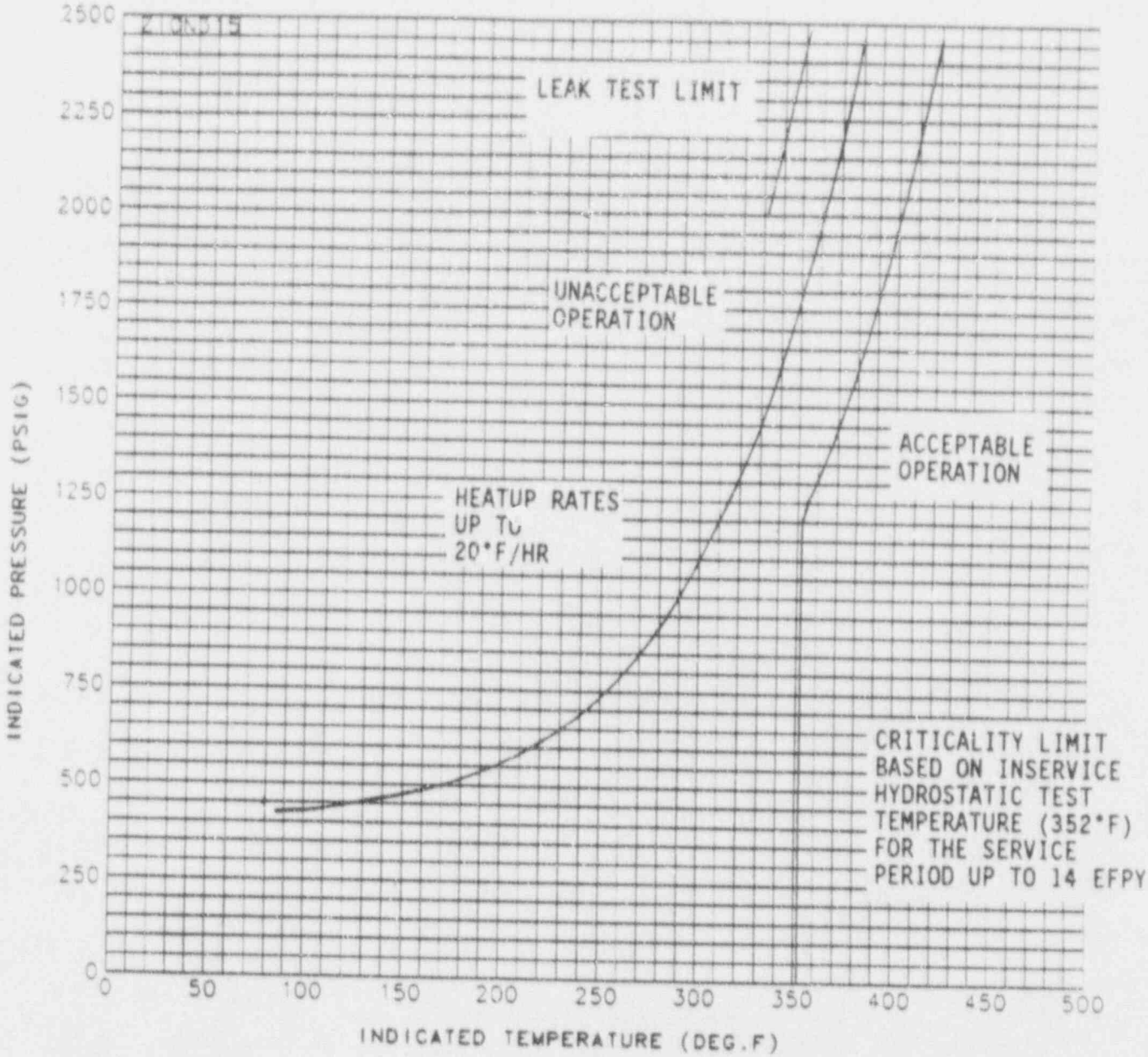


Figure 3. Reactor Coolant System Heatup Limitations (Heatup rates up to 20°F/hr) Applicable to Zion Units 1 and 2 for the First 14 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 14 EFPY: 1/4T = 206°F
3/4T = 161°F

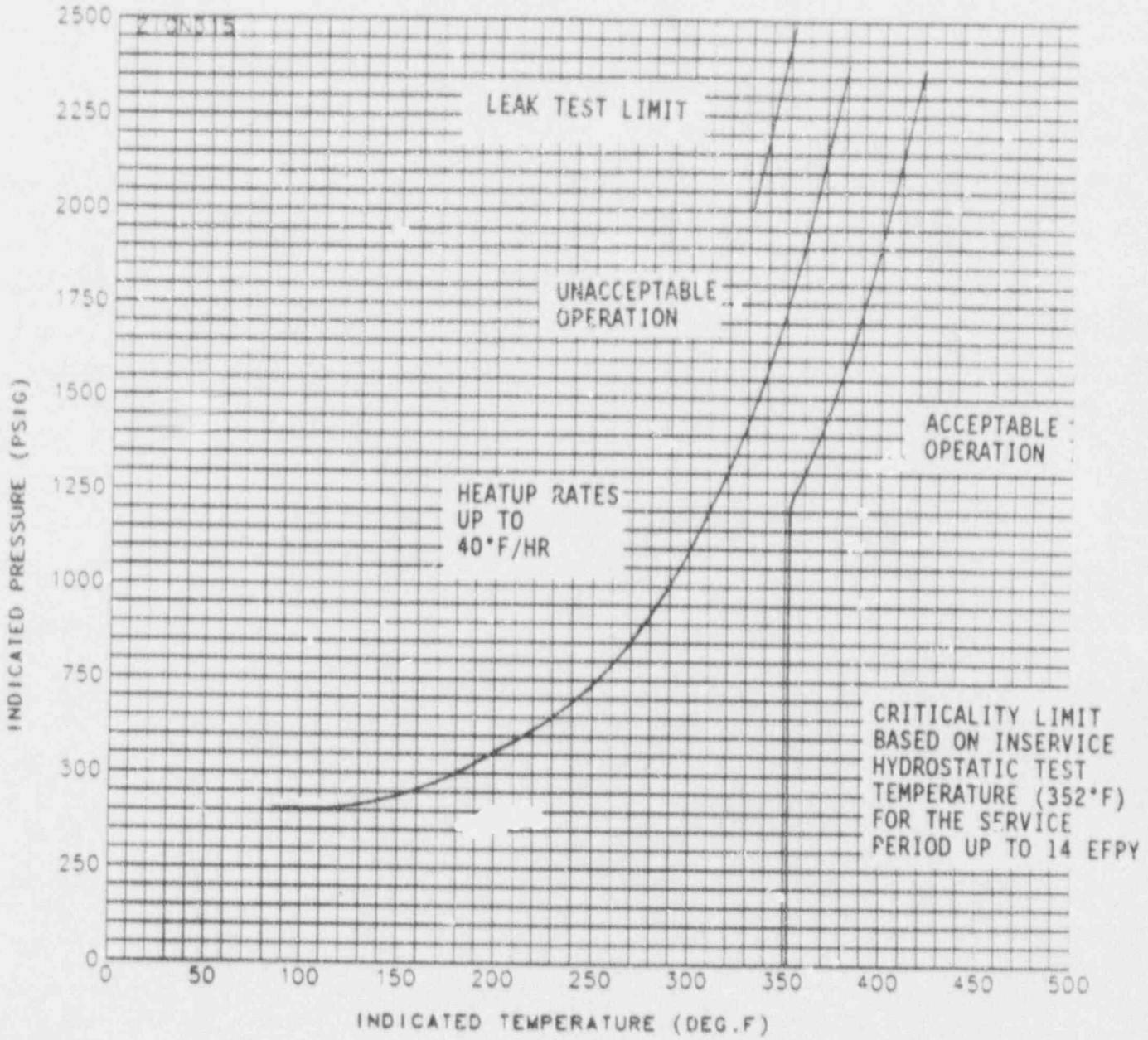


Figure 4. Reactor Coolant System Heatup Limitations (Heatup rates up to 40°F/hr) Applicable to Zion Units 1 and 2 for the First 14 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 14 EFPY: 1/4T = 206°F
3/4T = 161°F

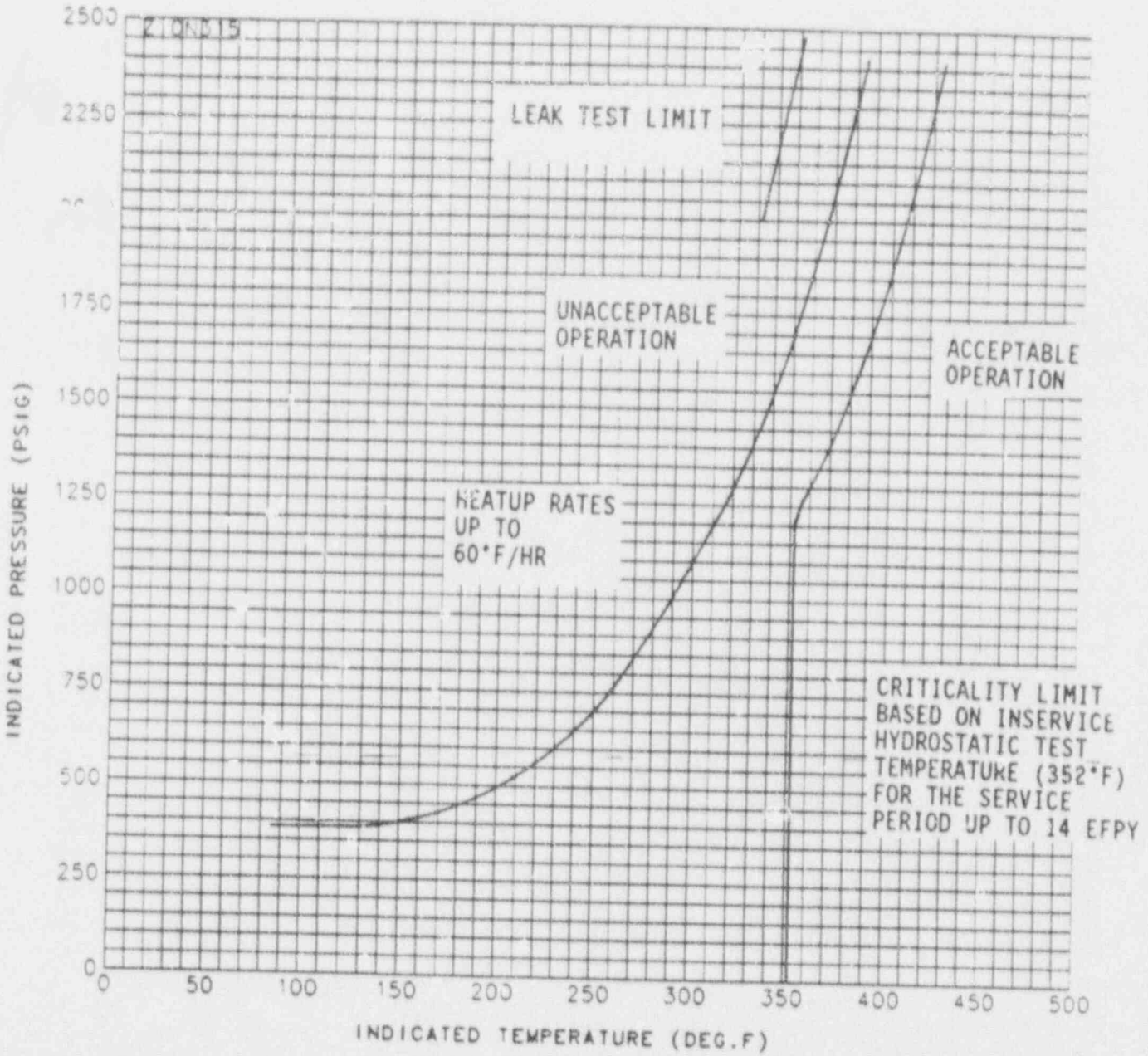


Figure 5. Reactor Coolant System Heatup Limitations (Heatup rates up to 60°F/hr) Applicable to Zion Units 1 and 2 for the First 14 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 14 EFPY: 1/4T = 206°F
3/4T = 161°F

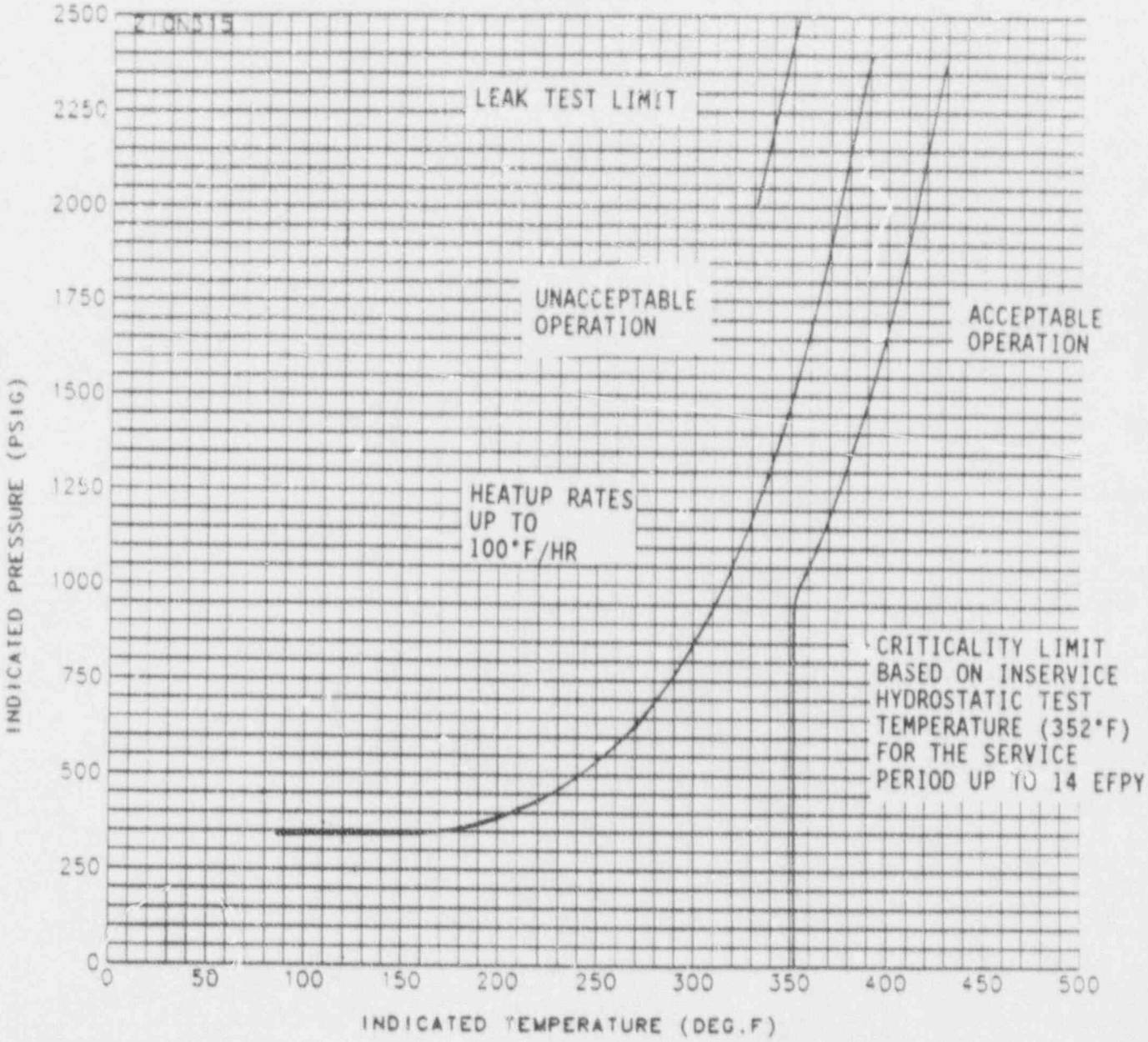


Figure 6. Reactor Coolant System Heatup Limitations (Heatup rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 14 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 20 EFPY: 1/4T = 222°F
3/4T = 175°F

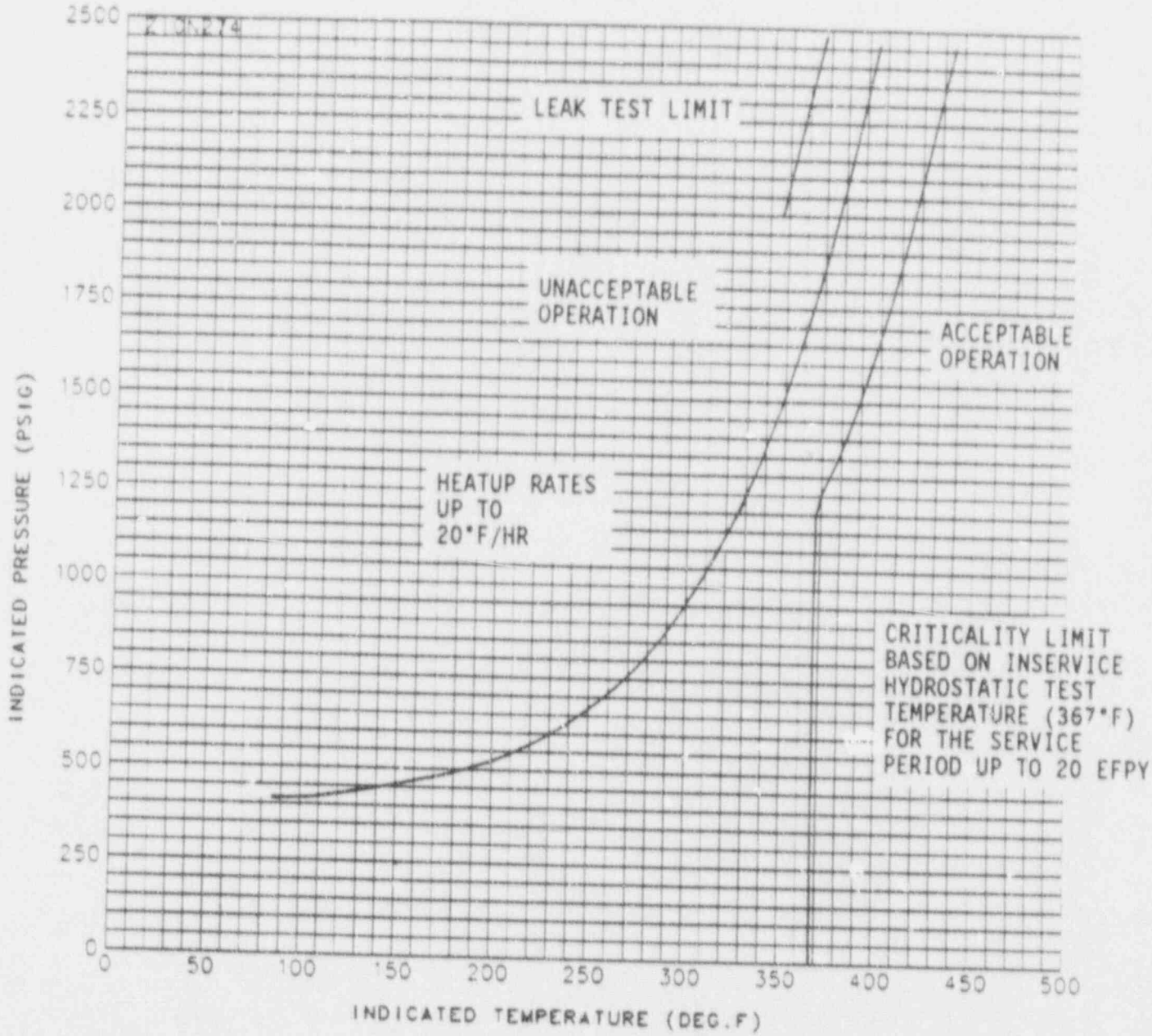


Figure 7. Reactor Coolant System Heatup Limitations (Heatup rates up to 20°F/hr) Applicable to Zion Units 1 and 2 for the First 20 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 20 EFPY: 1/4T = 222°F
3/4T = 175°F

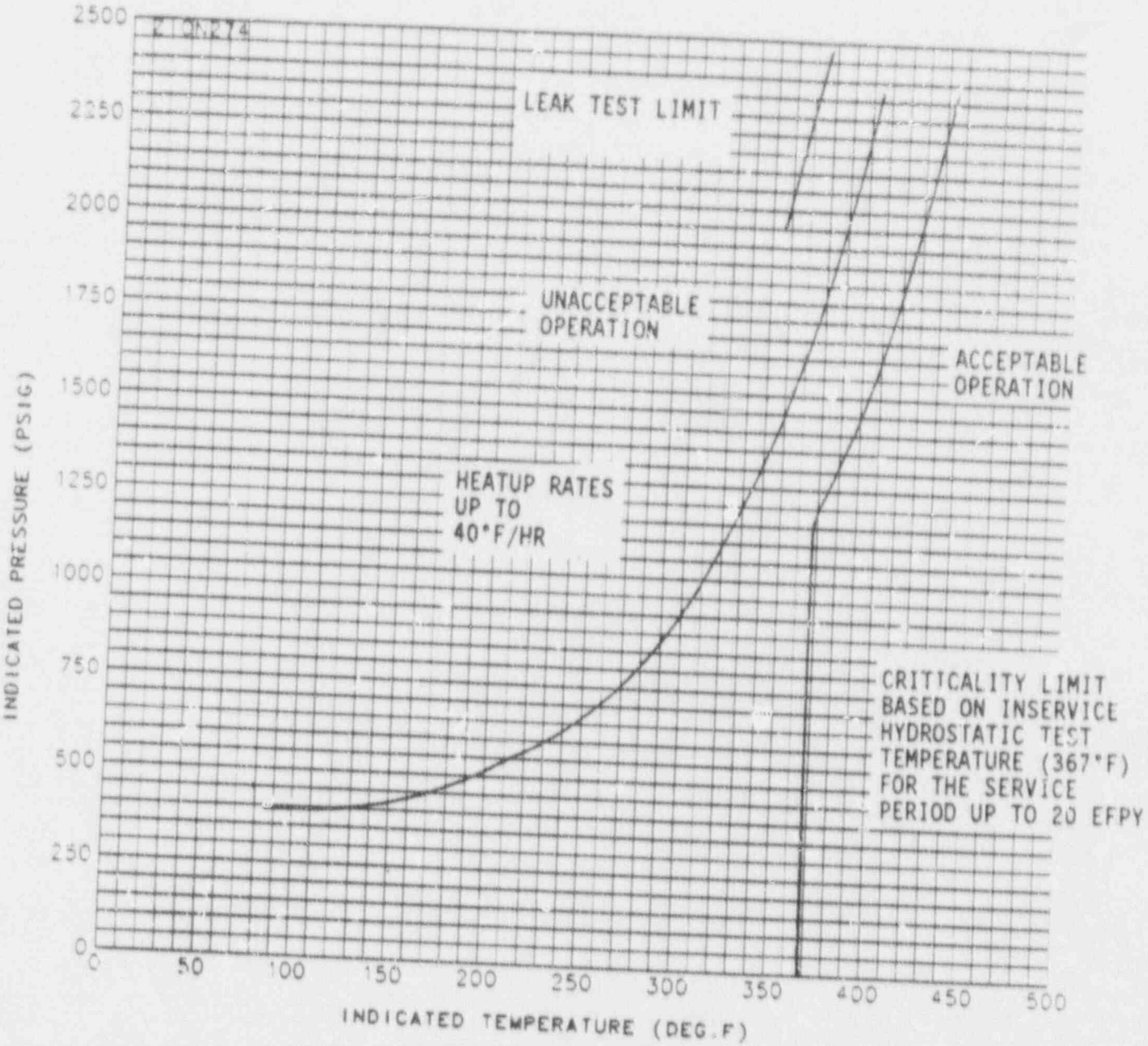


Figure 8. Reactor Coolant System Heatup Limitations (Heatup rates up to 40°F/hr) Applicable to Zion Units 1 and 2 for the First 20 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 20 EFPY: 1/4T = 222°F
3/4T = 175°F

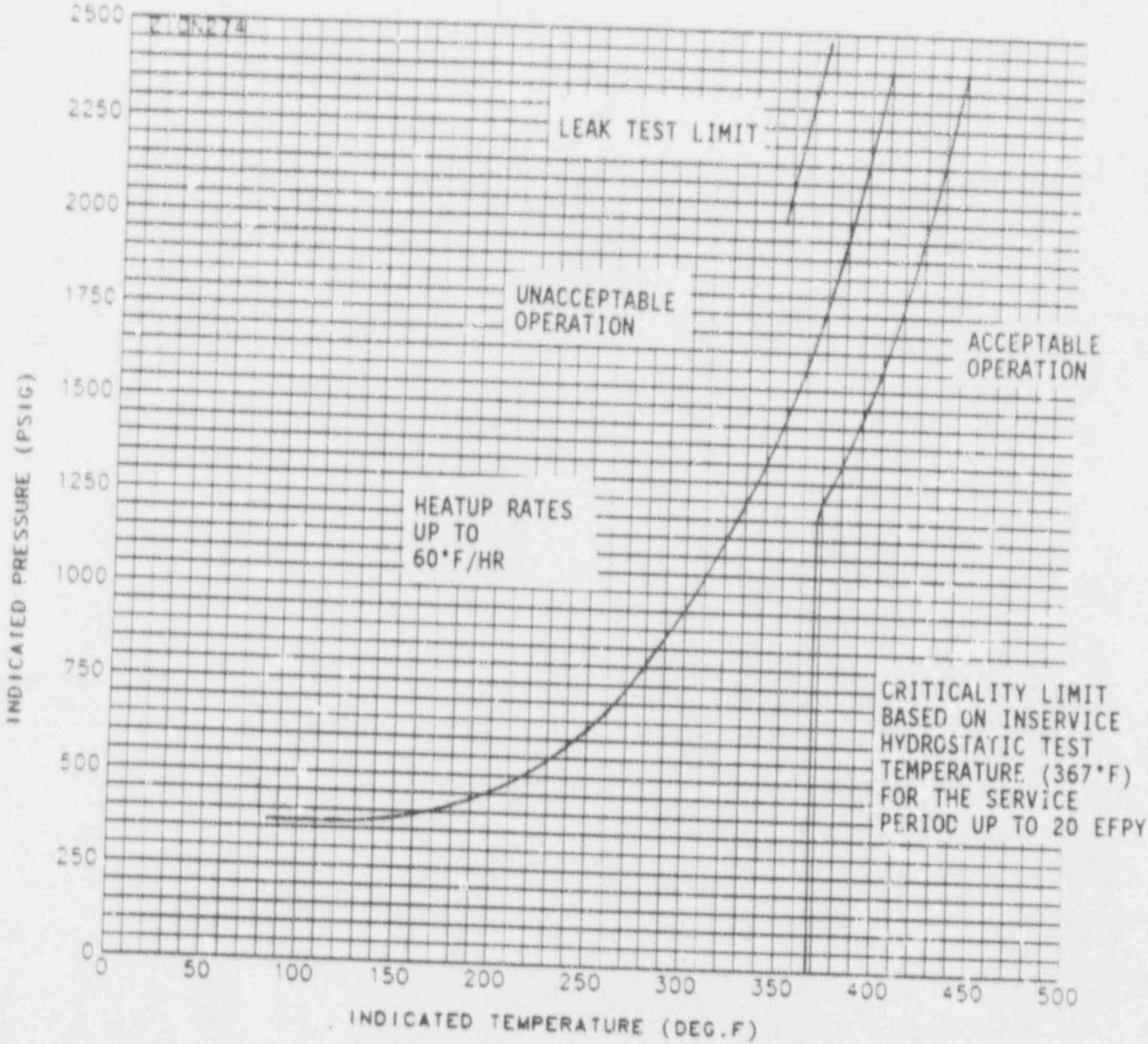


Figure 9. Reactor Coolant System Heatup Limitations (Heatup rates up to 60°F/hr) Applicable to Zion Units 1 and 2 for the First 20 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 20 EFPY: 1/4T = 222°F
3/4T = 175°F

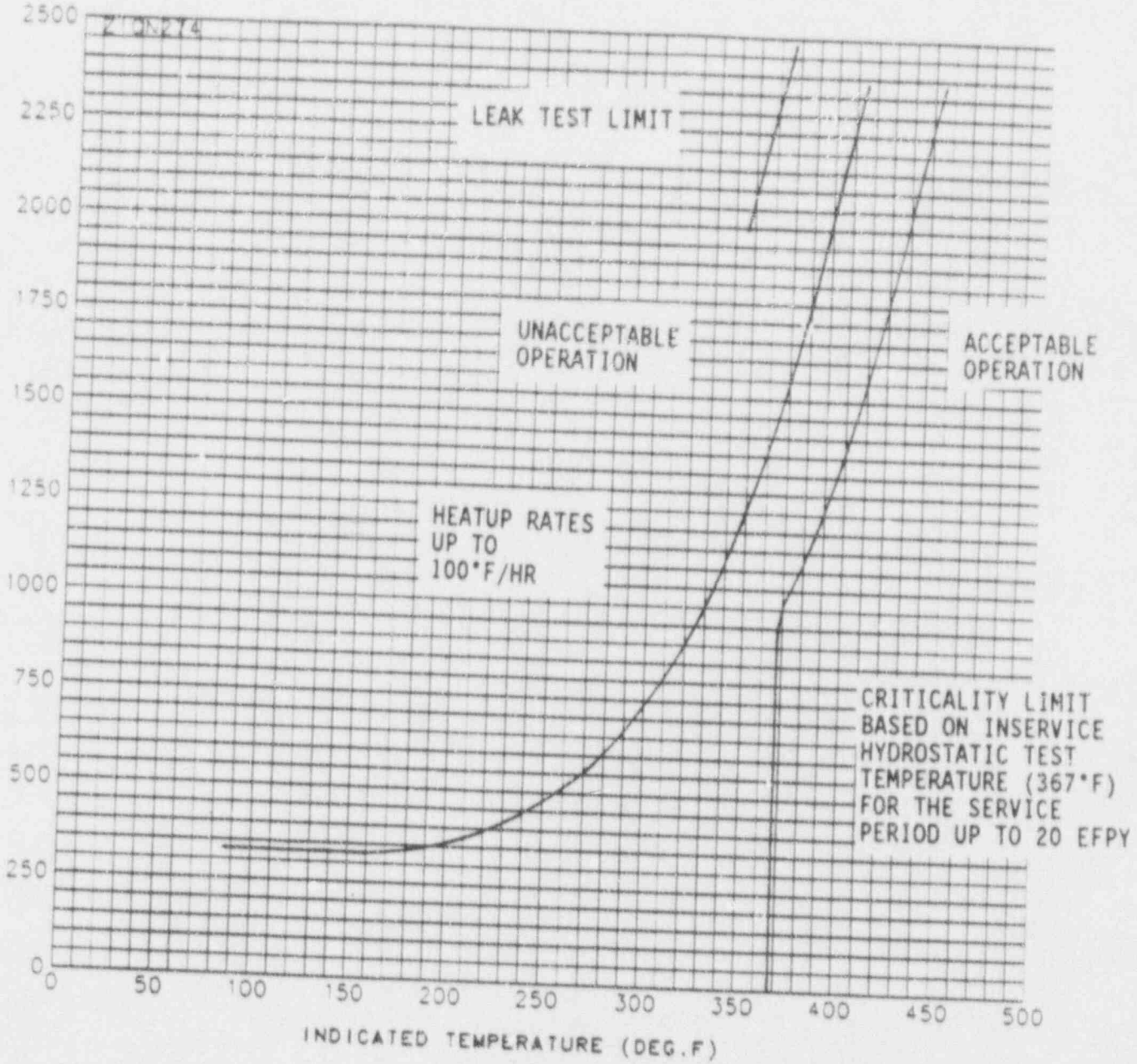


Figure 10. Reactor Coolant System Heatup Limitations (Heatup rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 20 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 25 EFPY: 1/4T = 232°F
3/4T = 184°F

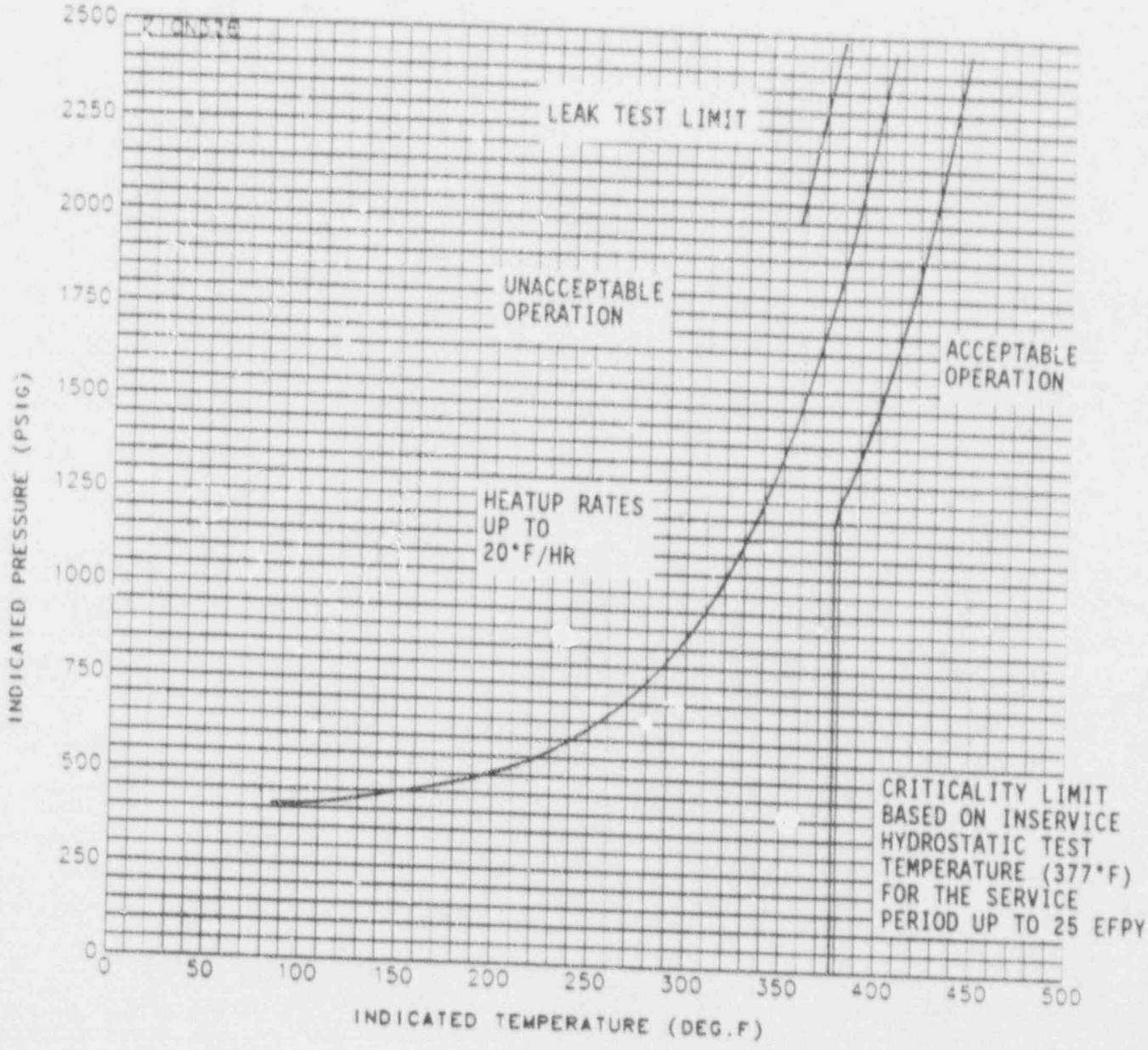


Figure 11. Reactor Coolant System Heatup Limitations (Heatup rates up to 20°F/hr) Applicable to Zion Units 1 and 2 for the First 25 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 25 EFPY: 1/4T = 232°F
3/4T = 184°F

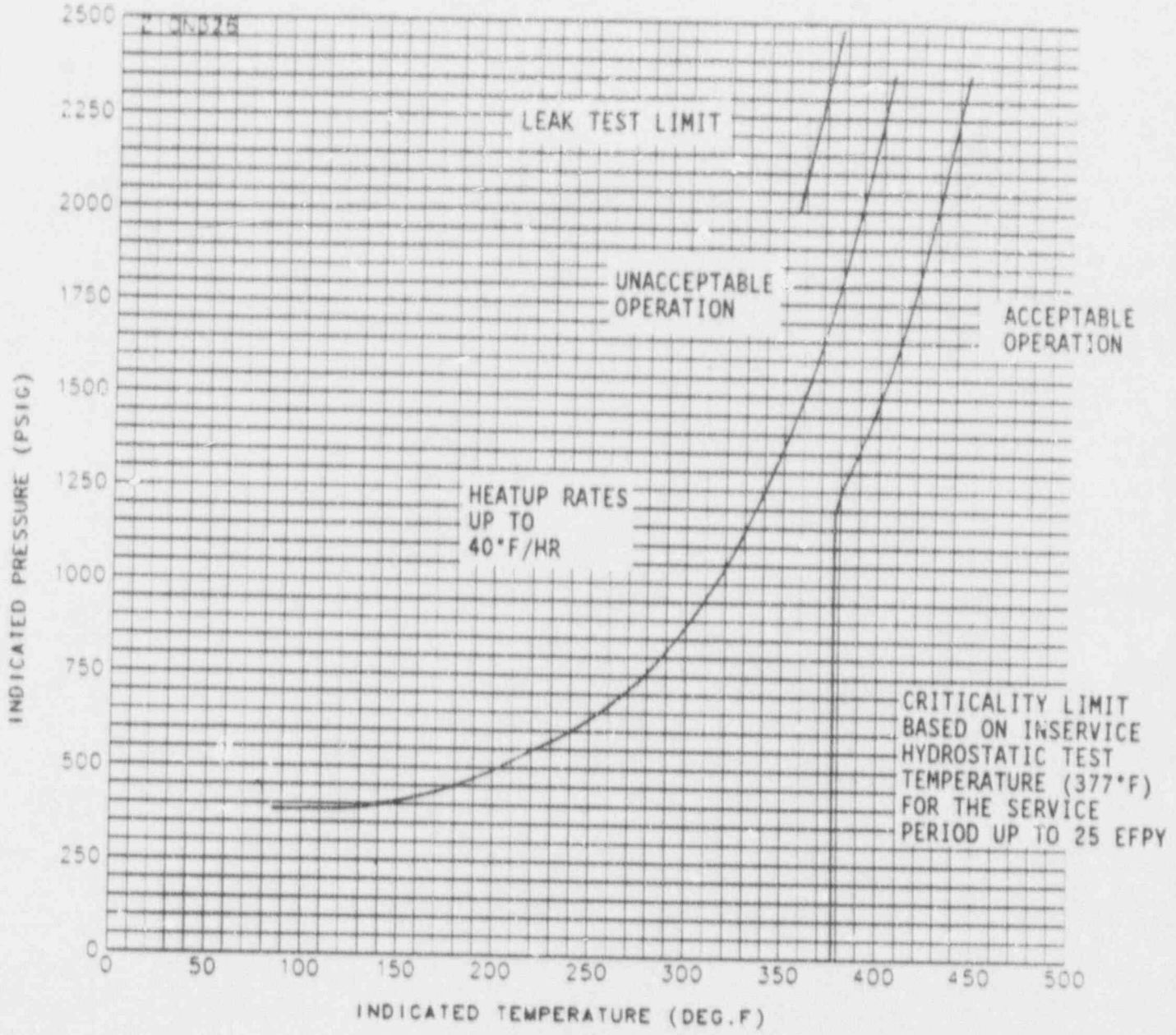


Figure 12. Reactor Coolant System Heatup Limitations (Heatup rates up to 40°F/hr) Applicable to Zion Units 1 and 2 for the First 25 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 25 EFPY: 1/4T = 232°F
3/4T = 184°F

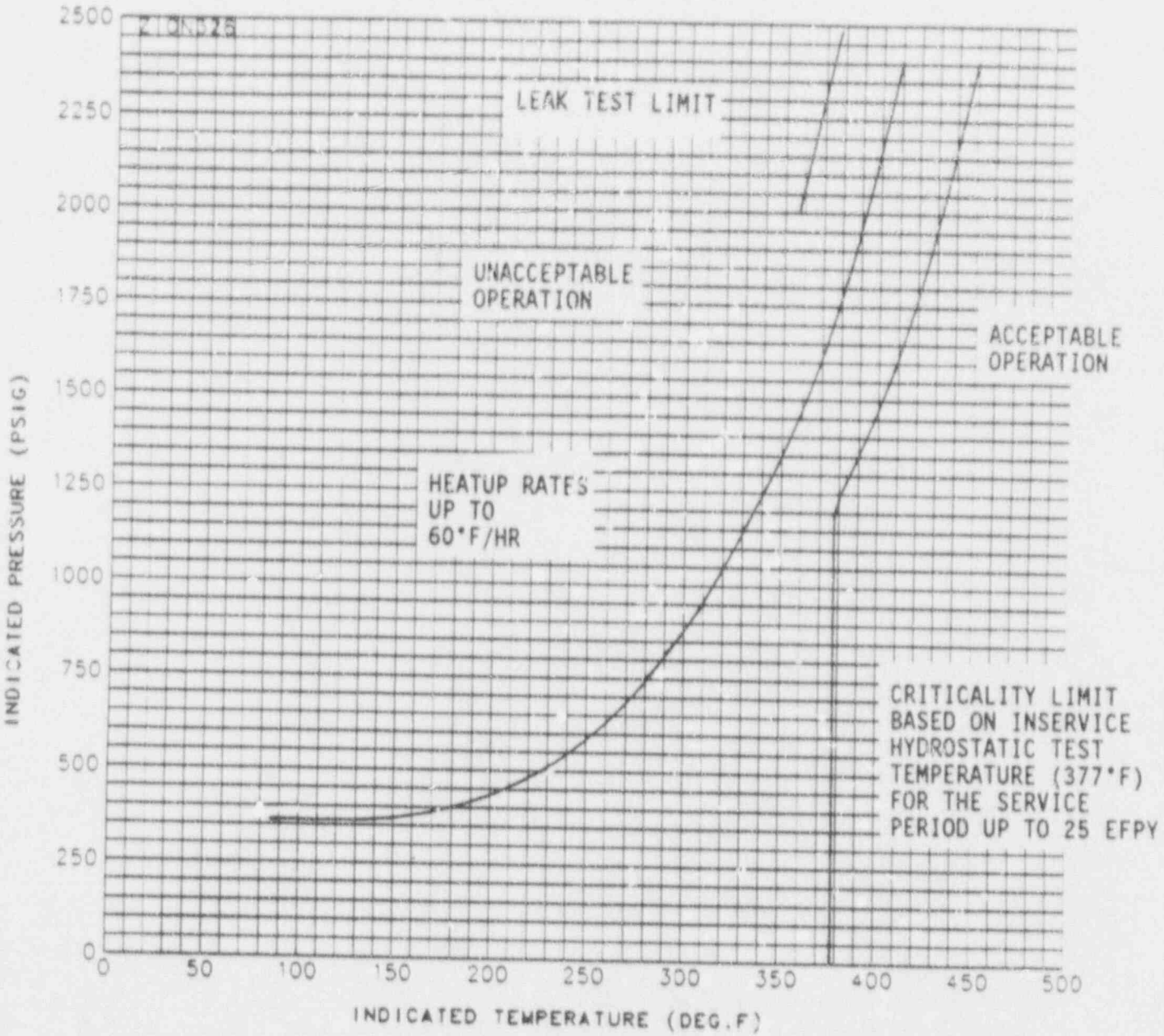


Figure 13. Reactor Coolant System Heatup Limitations (Heatup rates up to 60°F/hr) Applicable to Zion Units 1 and 2 for the First 25 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 25 EFPY: 1/4T = 232°F
3/4T = 184°F

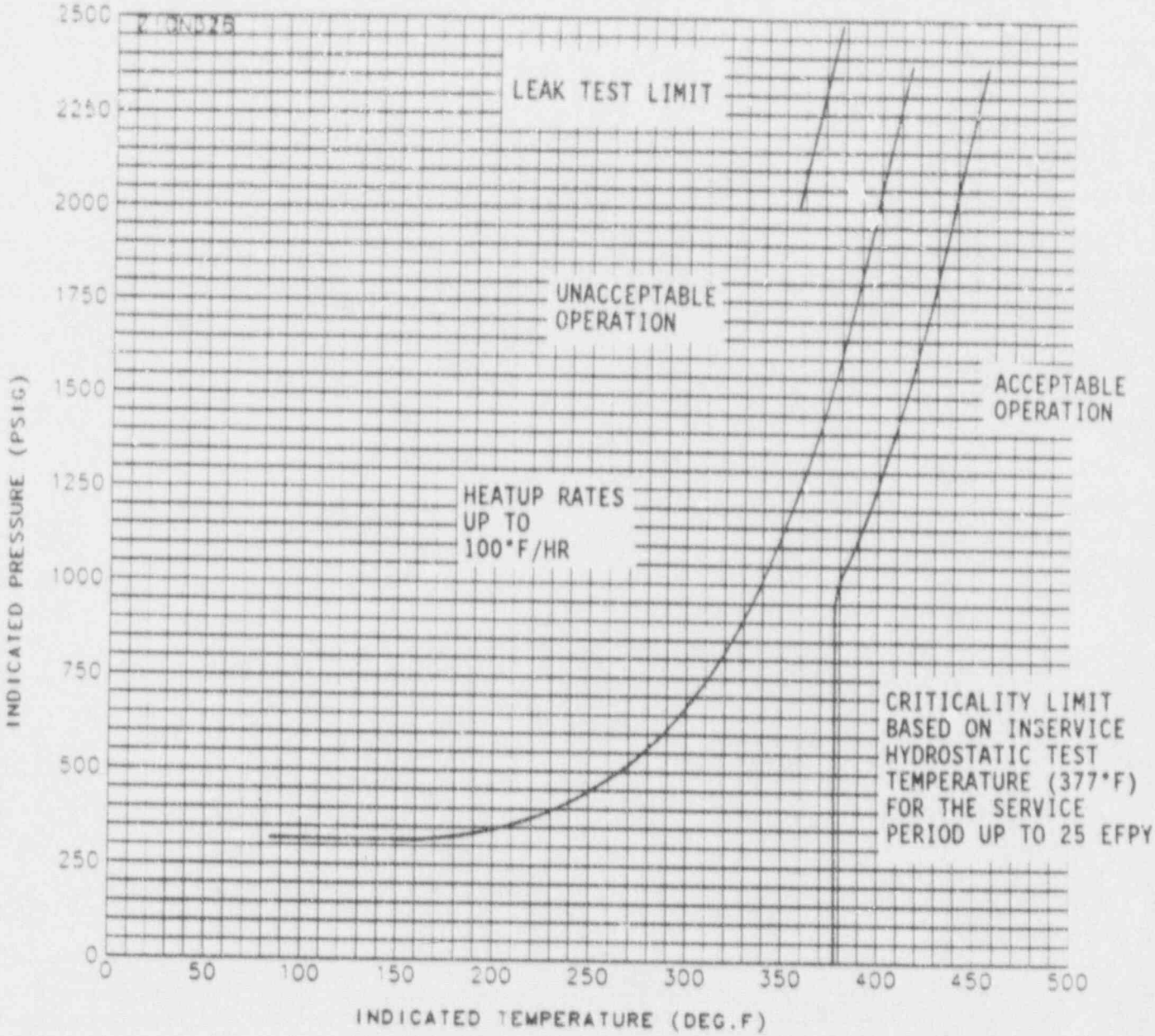


Figure 14. Reactor Coolant System Heatup Limitations (Heatup rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 25 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 32 EFPY: 1/4T = 243°F
3/4T = 194°F

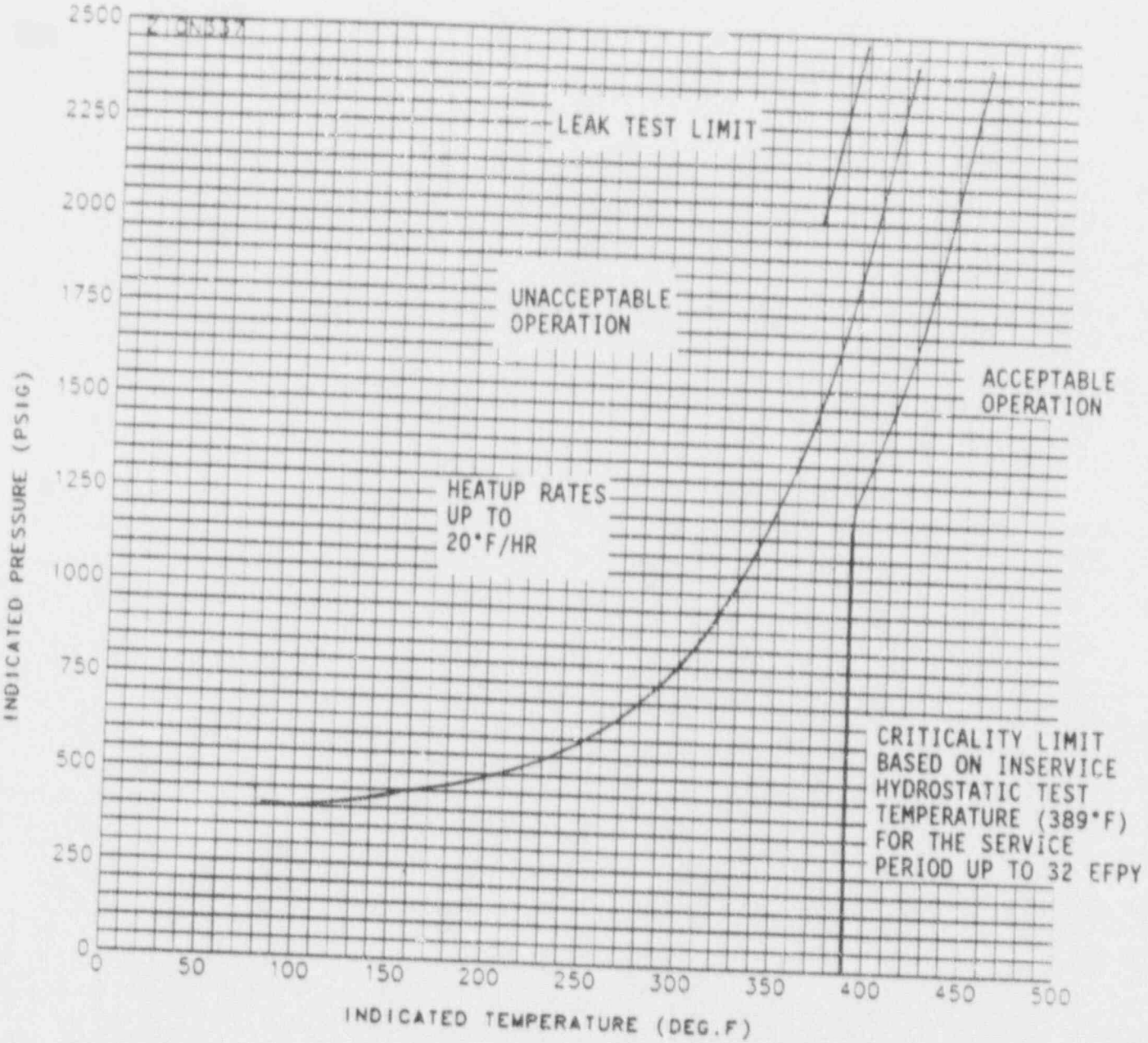


Figure 15. Reactor Coolant System Heatup Limitations (Heatup rates up to 20°F/hr) Applicable to Zion Units 1 and 2 for the First 32 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 32 EFPY: 1/4T = 243°F
3/4T = 194°F

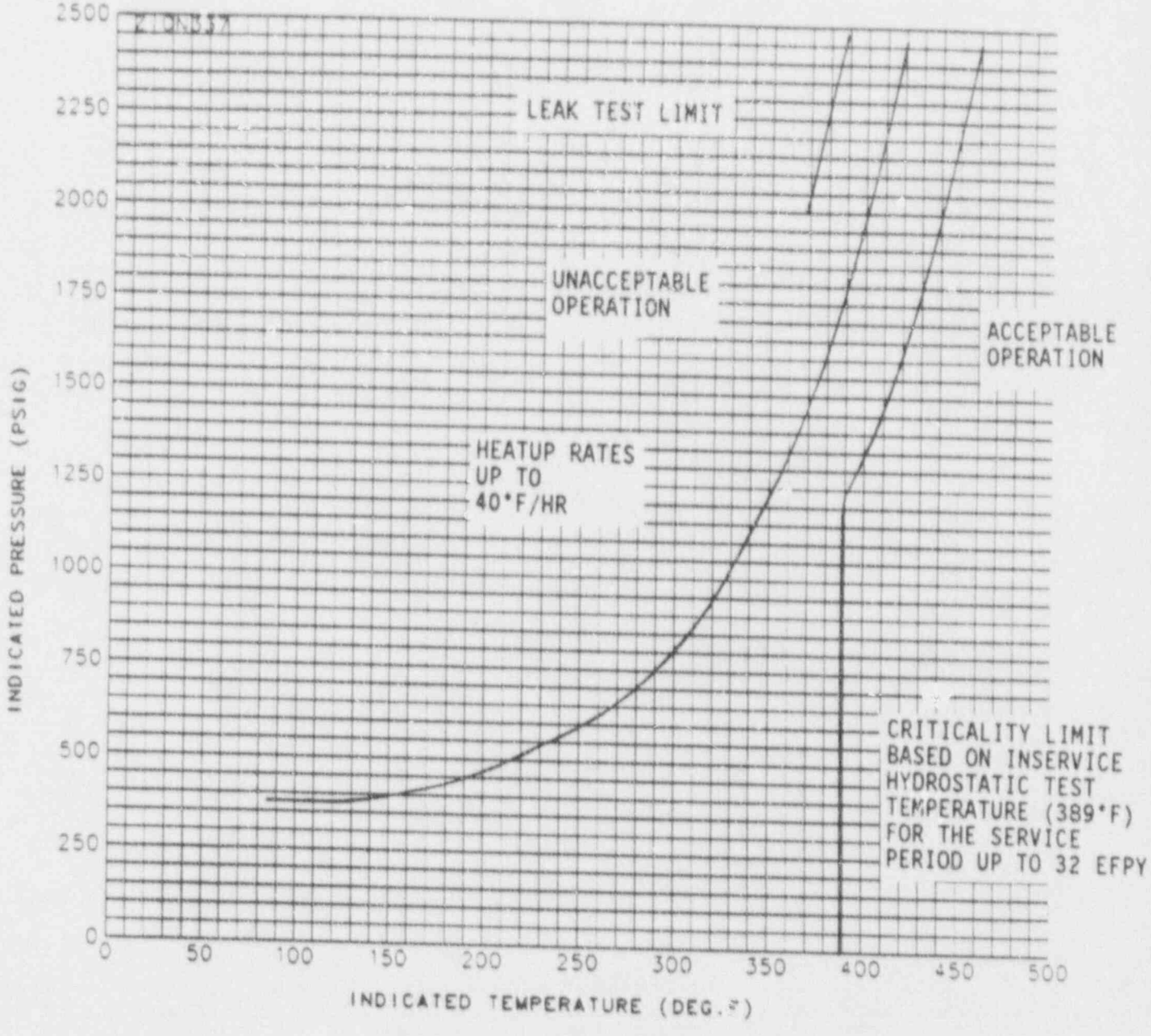


Figure 16. Reactor Coolant System Heatup Limitations (Heatup rates up to 40°F/hr) Applicable to Zion Units 1 and 2 for the First 32 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 32 EFPY: 1/4T = 243°F
3/4T = 194°F

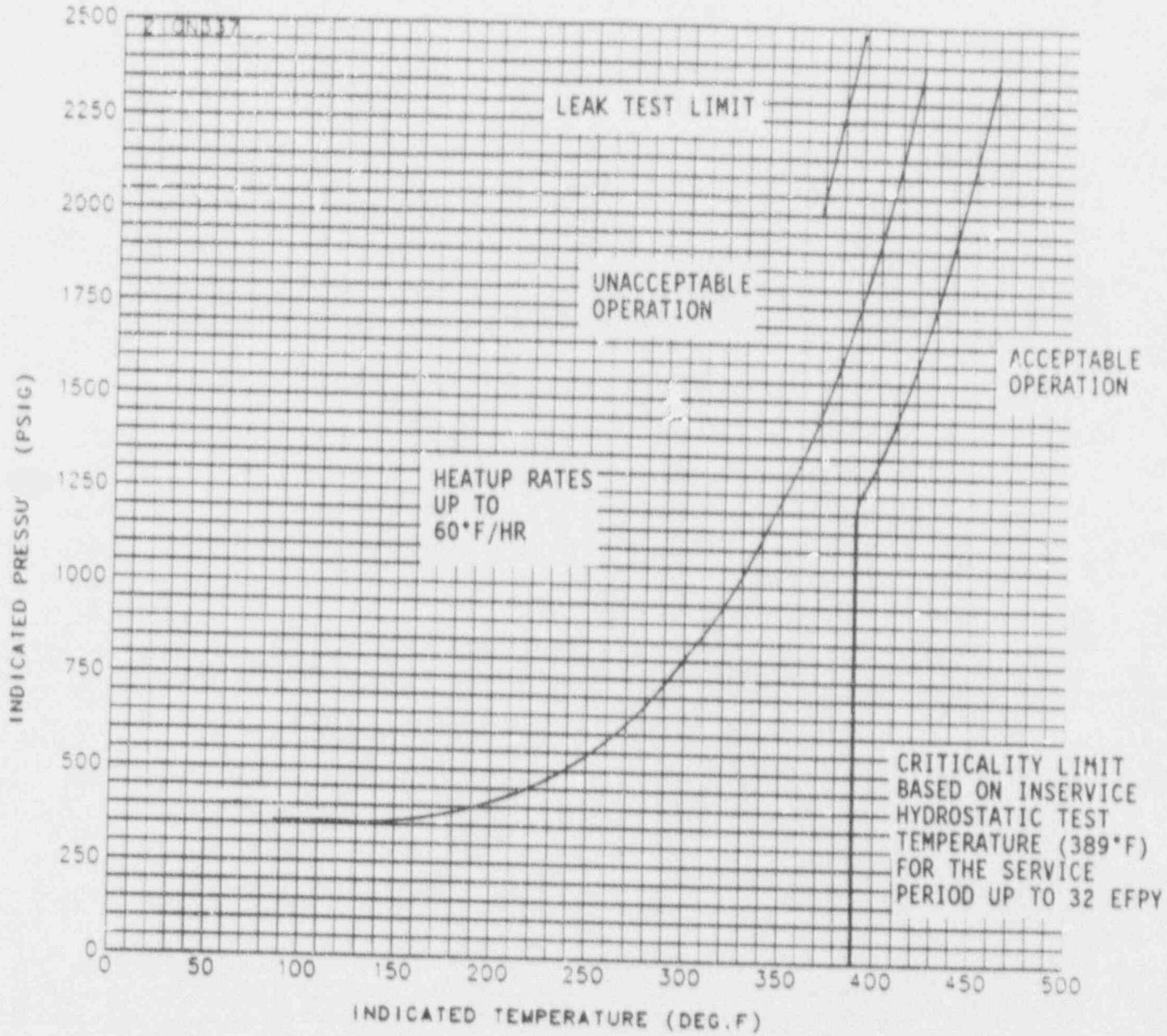


Figure 17. Reactor Coolant System Heatup Limitations (Heatup rates up to 60°F/hr) Applicable to Zion Units 1 and 2 for the First 32 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 32 EFPY: 1/4T = 243°F
3/4T = 194°F

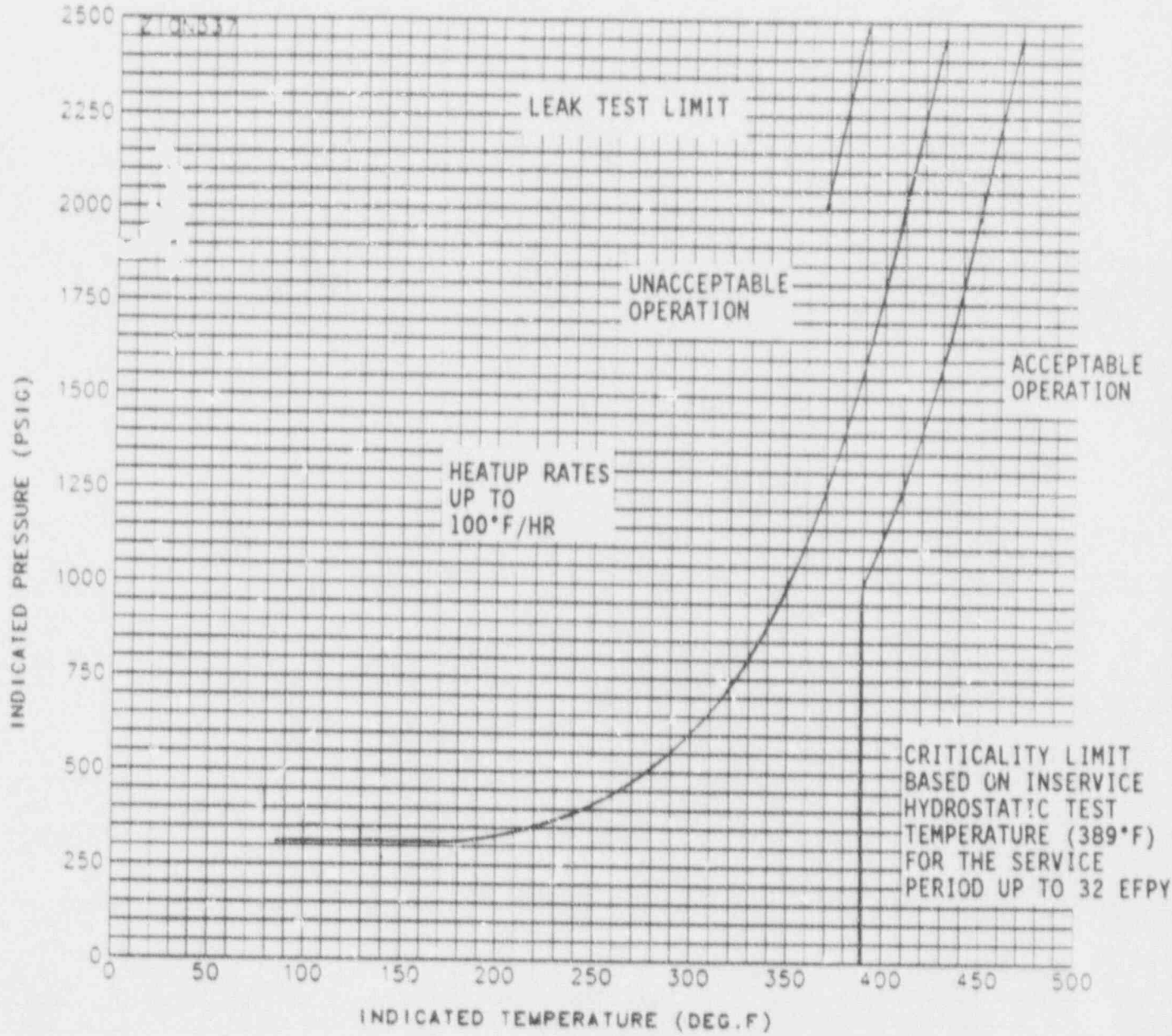


Figure 18. Reactor Coolant System Heatup Limitations (Heatup rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 32 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 14 EFPY: 1/4T = 206°F
3/4T = 161°F

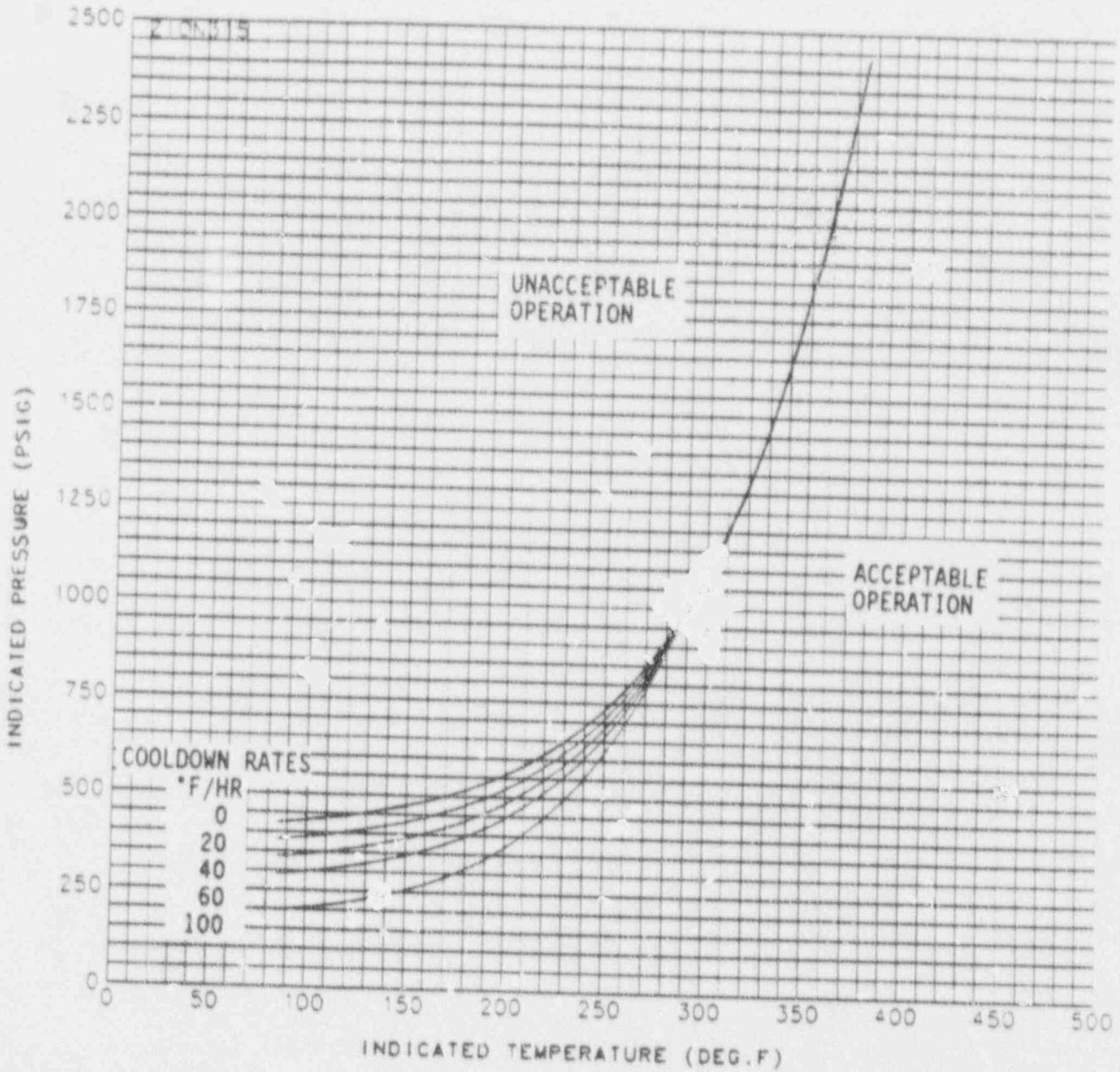


Figure 19. Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 14 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 20 EFPY: 1/4T = 222°F
3/4T = 175°F

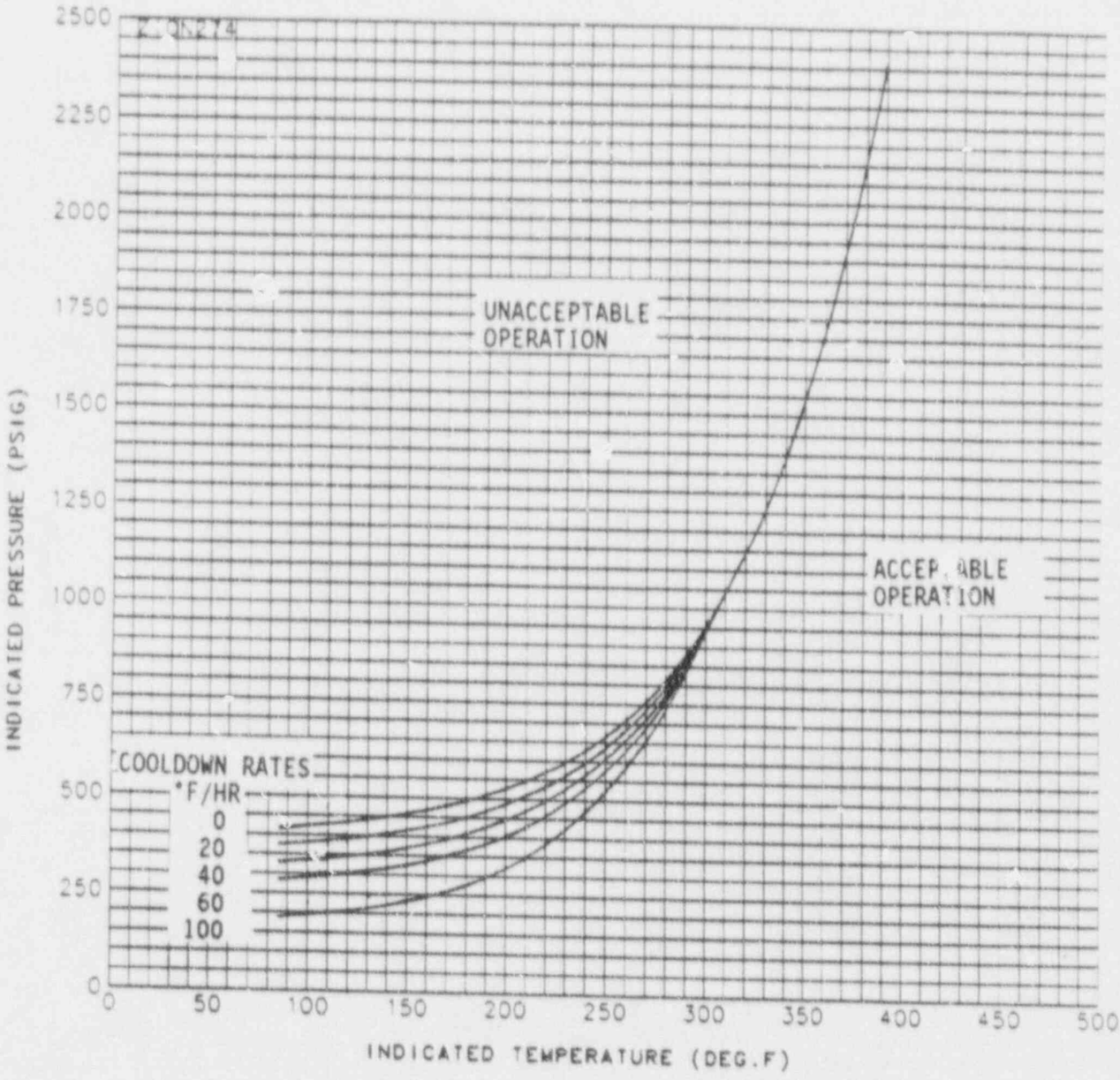


Figure 20. Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 20 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 25 EFPY: 1/4T = 232°F
3/4T = 184°F

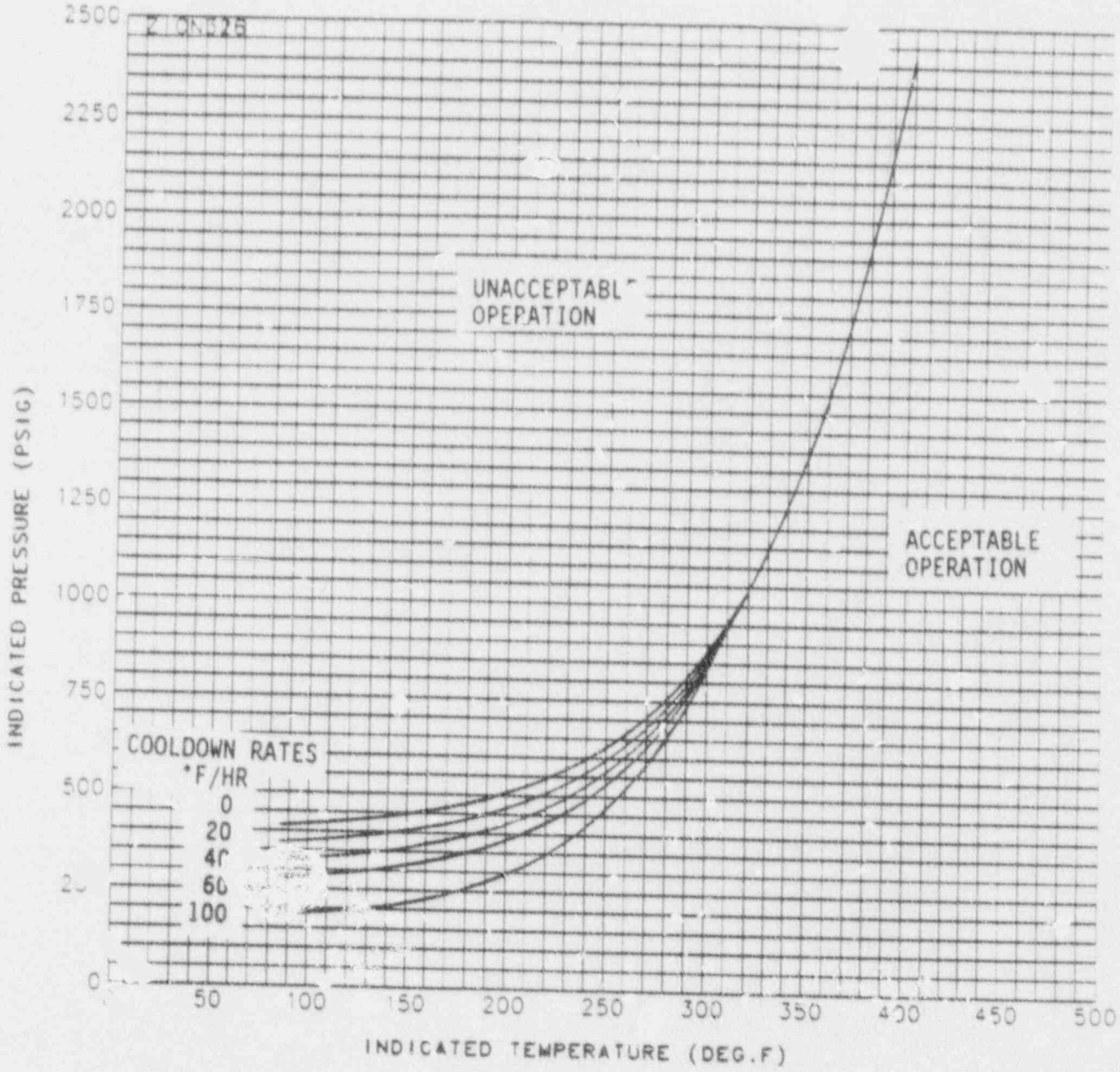


Figure 21. Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 25 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

MATERIAL PROPERTY BASIS

CONTROLLING MATERIAL: CIRCUMFERENTIAL WELD WF-70
INITIAL $RT_{NDT}$: 18°F
ART AT 32 EFPY: 1/4T = 243°F
3/4T = 194°F

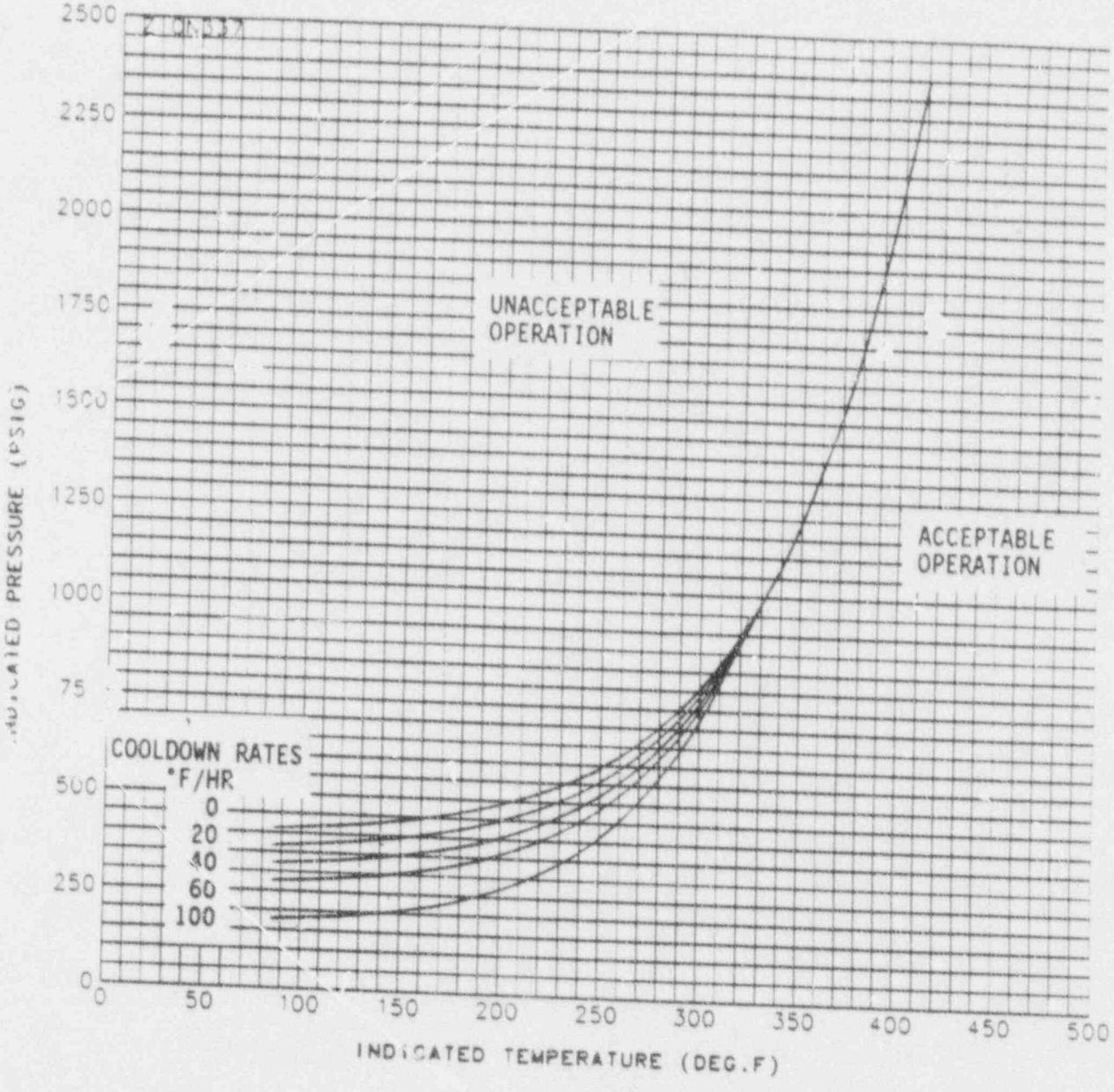


Figure 22. Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable to Zion Units 1 and 2 for the First 32 EFPY (With Margins of 10°F and 60 psig For Instrumentation Errors)

## 8. REFERENCES


1. Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials", U.S. Nuclear Regulatory Commission, May, 1988.

2. Code of Federal Regulations, 10CFR50, Appendix G, "fracture Toughness Requirements", U.S. Nuclear Regualtory Commission, Washington, D.C., Federal Register, Vol. 48 No. 104, May 27, 1983.

3. Commonwealth Edison Letter, "Materials Data for Use in Developing Revised Zion Units 1 and 2 Reactor Pressure Vessel Heatup and Cooldown Limit Curves", by Thomas D. Spry, et al., dated May 21, 1992.

4. "Fracture Toughness Requirements", Branch Technical Position MTEB 5-2, Chapter 5.3.2 in Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, NUREG-0800, 1981.

5. ASME Boiler and Pressure Vessel Code, Section III, Division 1 - Appendixes, "Rules for Construction of Nuclear Power Plant Components, Appendix G, Protection Against Nonductile Failure", pp. 558-563, 1986 Edition, American Society of Mechanical Engineers, New York, 1986.

6. WCAP-10962, Revision 2, "Zion Units 1 and 2 Reactor Vessel Fluence and $RT_{PTS}$ Evaluations", J.M. Chicots, et al., December 1990.

7. WCAP-11247, "Heatup and Cooldown Limit Curves for the Commonwealth Edison Company Zion Units 1 and 2 Reactor Vessel", H. Gong, et al., August 1986.

# APPENDIX A

## DATA POINTS FOR HEATUP AND COOLDOWN CURVES

(With Margins of 10°F and 60 psig for Instrumentation Errors)

CWE-COM 20 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE CALCULATEDFOR THE INSERVICE HYDROSTATIC LEAK TEST

MINIMUM INSERVICE LEAK TEST TEMPERATURE ( 14.000 EFPY)

| PRESSURE (PSI) | TEMPERATURE (DEG.F) |
|---|---|
| 2000 | 332 |
| 2485 | 352 |

| PRESSURE (PSI) | PRESSURE STRESS (PSI) | 1.5 K1M (PSI SQ RT IN.) |
|---|---|---|
| 2000 | 22234 | 92837 |
| 2485 | 27468 | 115765 |

CWE-COM 20 D.G-F/HR HEATUP REG.GUIDE 1.89,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 20.0

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = (1-A0W1N)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 424.28 | 21 | 185.000 | 526.04 | 41 | 285.000 | 958.00 |
| 2 | 90.000 | 426.64 | 22 | 190.000 | 536.06 | 42 | 290.000 | 1000.16 |
| 3 | 95.000 | 426.80 | 23 | 195.000 | 546.84 | 43 | 295.000 | 1045.48 |
| 4 | 100.000 | 427.42 | 24 | 200.000 | 558.42 | 44 | 300.000 | 1094.17 |
| 5 | 105.000 | 430.74 | 25 | 205.000 | 570.73 | 45 | 305.000 | 1144.94 |
| 6 | 110.000 | 434.76 | 26 | 210.000 | 584.12 | 46 | 310.000 | 1197.11 |
| 7 | 115.000 | 439.86 | 27 | 215.000 | 598.31 | 47 | 315.000 | 1253.04 |
| 8 | 120.000 | 444.88 | 28 | 220.000 | 613.95 | 48 | 320.000 | 1313.00 |
| 9 | 125.000 | 448.79 | 29 | 225.000 | 630.45 | 49 | 325.000 | 1377.25 |
| 10 | 130.000 | 453.00 | 30 | 230.000 | 648.34 | 50 | 330.000 | 1446.26 |
| 11 | 135.000 | 457.51 | 31 | 235.000 | 667.38 | 51 | 335.000 | 1520.18 |
| 12 | 140.000 | 462.37 | 32 | 240.000 | 688.04 | 52 | 340.000 | 1599.38 |
| 13 | 145.000 | 467.59 | 33 | 245.000 | 710.20 | 53 | 345.000 | 1684.26 |
| 14 | 150.000 | 473.21 | 34 | 250.000 | 733.93 | 54 | 350.000 | 1775.04 |
| 15 | 155.000 | 479.14 | 35 | 255.000 | 759.37 | 55 | 355.000 | 1872.25 |
| 16 | 160.000 | 485.63 | 36 | 260.000 | 786.97 | 56 | 360.000 | 1975.97 |
| 17 | 165.000 | 492.60 | 37 | 265.000 | 816.37 | 57 | 365.000 | 2087.26 |
| 18 | 170.000 | 500.11 | 38 | 270.000 | 848.15 | 58 | 370.000 | 2205.69 |
| 19 | 175.000 | 508.17 | 39 | 275.000 | 882.21 | 59 | 375.000 | 2332.66 |
| 20 | 180.000 | 516.84 | 40 | 280.000 | 918.76 | 60 | 380.000 | 2467.81 |

CWE-COM 40 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 40.0

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~424.28~~ | 21 | 185.000 | 513.23 | 41 | 285.000 | 958.00 |
| 2 | 90.000 | ~~422.18~~ | 22 | 190.000 | 527.05 | 42 | 290.000 | 1000.16 |
| 3 | 95.000 | ~~413.82~~ | 23 | 195.000 | 542.08 | 43 | 295.000 | 1045.48 |
| 4 | 100.000 | ~~408.11~~ | 24 | 200.000 | 558.24 | 44 | 300.000 | 1094.17 |
| 5 | 105.000 | ~~405.45~~ 404.79 | 25 | 205.000 | 570.73 | 45 | 305.000 | 1146.49 |
| 6 | 110.000 | 404.79 | 26 | 210.000 | 584.12 | 46 | 310.000 | 1195.44 |
| 7 | 115.000 | 405.83 | 27 | 215.000 | 598.51 | 47 | 315.000 | 1247.45 |
| 8 | 120.000 | 408.07 | 28 | 220.000 | 613.95 | 48 | 320.000 | 1303.25 |
| 9 | 125.000 | 411.49 | 29 | 225.000 | 630.45 | 49 | 325.000 | 1363.01 |
| 10 | 130.000 | 415.74 | 30 | 230.000 | 648.34 | 50 | 330.000 | 1427.11 |
| 11 | 135.000 | 420.91 | 31 | 235.000 | 667.38 | 51 | 335.000 | 1495.74 |
| 12 | 140.000 | 426.76 | 32 | 240.000 | 688.04 | 52 | 340.000 | 1569.33 |
| 13 | 145.000 | 433.31 | 33 | 245.000 | 710.20 | 53 | 345.000 | 1647.88 |
| 14 | 150.000 | 440.60 | 34 | 250.000 | 733.93 | 54 | 350.000 | 1732.50 |
| 15 | 155.000 | 448.67 | 35 | 255.000 | 759.37 | 55 | 355.000 | 1822.69 |
| 16 | 160.000 | 457.40 | 36 | 260.000 | 786.97 | 56 | 360.000 | 1919.40 |
| 17 | 165.000 | 466.94 | 37 | 265.000 | 816.37 | 57 | 365.000 | 2022.33 |
| 18 | 170.000 | 477.11 | 38 | 270.000 | 848.15 | 58 | 370.000 | 2132.79 |
| 19 | 175.000 | 488.27 | 39 | 275.000 | 882.21 | 59 | 375.000 | 2250.61 |
| 20 | 180.000 | 500.26 | 40 | 280.000 | 918.76 | 60 | 380.000 | 2376.31 |

A3

CWE-COM 60 DEG-F/HR HEATUP REG.GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 60.0

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~424.23~~ | 22 | 190.000 | 467.25 | 42 | 290.000 | 1000.16 |
| 2 | 90.000 | ~~422.08~~ | 23 | 195.000 | 479.68 | 43 | 295.000 | 1045.48 |
| 3 | 95.000 | ~~405.48~~ | 24 | 200.000 | 493.23 | 44 | 300.000 | 1094.17 |
| 4 | 100.000 | ~~355.80~~ 383.66 | 25 | 205.000 | 507.89 | 45 | 305.000 | 1146.49 |
| 5 | 105.000 | ~~992.96~~ | 26 | 210.000 | 523.56 | 46 | 310.000 | 1197.19 |
| 6 | 110.000 | ~~388.04~~ | 27 | 215.000 | 540.62 | 47 | 315.000 | 1245.68 |
| 7 | 115.000 | ~~385.13~~ | 28 | 220.000 | 558.98 | 48 | 320.000 | 1297.61 |
| 8 | 120.000 | 383.66 | 28 | 225.000 | 578.63 | 49 | 325.000 | 1353.27 |
| 9 | 125.000 | 383.65 | 30 | 230.000 | 599.91 | 50 | 330.000 | 1412.95 |
| 10 | 130.000 | 384.72 | 31 | 235.000 | 622.67 | 51 | 335.000 | 1476.82 |
| 11 | 135.000 | 386.94 | 32 | 240.000 | 647.31 | 52 | 340.000 | 1545.37 |
| 12 | 140.000 | 390.04 | 33 | 245.000 | 673.63 | 53 | 345.000 | 1618.64 |
| 13 | 145.000 | 394.11 | 34 | 250.000 | 702.10 | 54 | 350.000 | 1696.89 |
| 14 | 150.000 | 398.96 | 35 | 255.000 | 732.54 | 55 | 355.000 | 1781.08 |
| 15 | 155.000 | 404.67 | 36 | 260.000 | 765.21 | 56 | 360.000 | 1870.83 |
| 16 | 160.000 | 411.13 | 37 | 265.000 | 800.51 | 57 | 365.000 | 1966.79 |
| 17 | 165.000 | 418.43 | 38 | 270.000 | 838.29 | 58 | 370.000 | 2069.26 |
| 18 | 170.000 | 426.50 | 39 | 275.000 | 878.85 | 59 | 375.000 | 2178.93 |
| 19 | 175.000 | 435.33 | 40 | 280.000 | 918.76 | 60 | 380.000 | 2295.93 |
| 20 | 180.000 | 445.06 | 41 | 285.000 | 958.60 | 61 | 385.000 | 2420.60 |
| 21 | 185.000 | 455.71 | | | | | | |

A4

CWE-COM 100 DEG-F/HR HEATUP REG GUIDE 1.99,REV 2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 100.0

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = (1-AO/INT

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~424.28~~ | 383.24 | 22 | 190.000 | 372.96 | 43 | 295.000 | 805.37 |
| 2 | 90.000 | ~~424.46~~ | | 23 | 195.000 | 380.57 | 44 | 300.000 | 847.81 |
| 3 | 95.000 | ~~400.85~~ | | 24 | 200.000 | 389.14 | 45 | 305.000 | 893.36 |
| 4 | 100.000 | ~~395.08~~ | | 25 | 205.000 | 398.65 | 46 | 310.000 | 942.24 |
| 5 | 105.000 | 383.24 | | 26 | 210.000 | 409.13 | 47 | 315.000 | 994.51 |
| 6 | 110.000 | 373.14 | | 27 | 215.000 | 420.64 | 48 | 320.000 | 1050.84 |
| 7 | 115.000 | 364.78 | | 28 | 220.000 | 433.12 | 49 | 325.000 | 1111.25 |
| 8 | 120.000 | 357.84 | | 29 | 225.000 | 446.82 | 50 | 330.000 | 1175.91 |
| 9 | 125.000 | 352.38 | | 30 | 230.000 | 461.71 | 51 | 335.000 | 1245.19 |
| 10 | 130.000 | 348.11 | | 31 | 235.000 | 477.77 | 52 | 340.000 | 1319.40 |
| 11 | 135.000 | 345.07 | | 32 | 240.000 | 495.26 | 53 | 345.000 | 1398.79 |
| 12 | 140.000 | 343.06 | | 33 | 245.000 | 514.19 | 54 | 350.000 | 1483.86 |
| 13 | 145.000 | 342.15 | | 34 | 250.000 | 534.51 | 55 | 355.000 | 1574.79 |
| 14 | 150.000 | 342.12 | | 35 | 255.000 | 556.58 | 56 | 360.000 | 1672.04 |
| 15 | 155.000 | 343.03 | | 36 | 260.000 | 580.23 | 57 | 365.000 | 1776.03 |
| 16 | 160.000 | 344.72 | | 37 | 265.000 | 605.87 | 58 | 370.000 | 1886.88 |
| 17 | 165.000 | 347.35 | | 38 | 270.000 | 633.31 | 59 | 375.000 | 2005.42 |
| 18 | 170.000 | 350.80 | | 39 | 275.000 | 662.99 | 60 | 380.000 | 2131.77 |
| 19 | 175.000 | 355.09 | | 40 | 280.000 | 694.82 | 61 | 385.000 | 2266.15 |
| 20 | 180.000 | 360.20 | | 41 | 285.000 | 729.00 | 62 | 390.000 | 2388.95 |
| 21 | 185.000 | 366.16 | | 42 | 290.000 | 765.73 | | | |

CWE-COM HEATUP CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE CALCULATEDFOR THE INSERVICE HYDROSTATIC LEAK TEST

MINIMUM INSERVICE LEAK TEST TEMPERATURE ( 20.000 EFPY)

| PRESSURE (PSI) | TEMPERATURE (DEG.F) |
|---|---|
| 2000 | 347 |
| 2485 | 367 |

| PRESSURE (PSI) | PRESSURE STRESS (PSI) | 1.5 K1M (PSI SQ.RT.IN.) |
|---|---|---|
| 2000 | 22234 | 92837 |
| 2485 | 27468 | 115765 |

CWE-COM HEATUP CURVES REG. GUIDE 1.99,REV 2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 20.0

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = (1-AOWIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~418.06~~ | 22 | 190.000 | 507.72 | 43 | 295.000 | 916.70 |
| 2 | 90.000 | ~~416.05~~ 415.83 | 23 | 195.000 | 516.36 | 44 | 300.000 | 955.79 |
| 3 | 95.000 | ~~415.84~~ | 24 | 200.000 | 525.52 | 45 | 305.000 | 997.79 |
| 4 | 100.000 | 415.33 | 25 | 205.000 | 535.50 | 46 | 310.000 | 1042.92 |
| 5 | 105.000 | 418.43 | 26 | 210.000 | 546.23 | 47 | 315.000 | 1091.42 |
| 6 | 110.000 | 421.56 | 27 | 215.000 | 557.77 | 48 | 320.000 | 1142.32 |
| 7 | 115.000 | 425.70 | 28 | 220.000 | 570.03 | 49 | 325.000 | 1194.27 |
| 8 | 120.000 | 430.14 | 29 | 225.000 | 583.37 | 50 | 330.000 | 1249.99 |
| 9 | 125.000 | 435.27 | 30 | 230.000 | 597.71 | 51 | 335.000 | 1309.69 |
| 10 | 130.000 | 440.77 | 31 | 235.000 | 613.09 | 52 | 340.000 | 1373.55 |
| 11 | 135.000 | 444.68 | 32 | 240.000 | 629.53 | 53 | 345.000 | 1442.35 |
| 12 | 140.000 | 448.57 | 33 | 245.000 | 647.34 | 54 | 350.000 | 1515.82 |
| 13 | 145.000 | 452.76 | 34 | 250.000 | 666.30 | 55 | 355.000 | 1594.77 |
| 14 | 150.000 | 457.26 | 35 | 255.000 | 686.89 | 56 | 360.000 | 1679.25 |
| 15 | 155.000 | 462.10 | 36 | 260.000 | 708.96 | 57 | 365.000 | 1769.63 |
| 16 | 160.000 | 467.30 | 37 | 265.000 | 732.60 | 58 | 370.000 | 1866.39 |
| 17 | 165.000 | 472.89 | 38 | 270.000 | 758.08 | 59 | 375.000 | 1969.96 |
| 18 | 170.000 | 478.80 | 39 | 275.000 | 785.43 | 60 | 380.000 | 2080.61 |
| 19 | 175.000 | 485.26 | 40 | 280.000 | 814.71 | 61 | 385.000 | 2198.72 |
| 20 | 180.000 | 492.21 | 41 | 285.000 | 846.40 | 62 | 390.000 | 2324.95 |
| 21 | 185.000 | 499.69 | 42 | 290.00 | 880.30 | 63 | 395.000 | 2459.51 |

CWE-COM HEATUP CURVES REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 40.0

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = (1-AOWIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~418.06~~ | 22 | 190.000 | 490.80 | 43 | 295.000 | 916.70 |
| 2 | 90.000 | ~~412.15~~ 392.72 | 23 | 195.000 | 503.15 | 44 | 300.000 | 955.79 |
| 3 | 95.000 | ~~409.29~~ | 24 | 200.000 | 516.41 | 45 | 305.000 | 997.79 |
| 4 | 100.000 | ~~397.27~~ | 25 | 205.000 | 530.59 | 46 | 310.000 | 1042.92 |
| 5 | 105.000 | ~~394.08~~ | 26 | 210.000 | 545.96 | 47 | 315.000 | 1091.42 |
| 6 | 110.000 | 392.72 | 27 | 215.000 | 557.77 | 48 | 320.000 | 1143.53 |
| 7 | 115.000 | 393.01 | 28 | 220.000 | 570.03 | 49 | 325.000 | 1192.94 |
| 8 | 120.000 | 394.41 | 29 | 225.000 | 583.37 | 50 | 330.000 | 1244.78 |
| 9 | 125.000 | 396.89 | 30 | 230.000 | 597.71 | 51 | 335.000 | 1300.24 |
| 10 | 130.000 | 400.14 | 31 | 235.000 | 613.09 | 52 | 340.000 | 1359.74 |
| 11 | 135.000 | 404.20 | 32 | 240.000 | 629.53 | 53 | 345.000 | 1423.37 |
| 12 | 140.000 | 408.85 | 33 | 245.000 | 647.34 | 54 | 350.000 | 1491.78 |
| 13 | 145.000 | 414.20 | 34 | 250.000 | 666.30 | 55 | 355.000 | 1564.93 |
| 14 | 150.000 | 420.10 | 35 | 255.000 | 686.89 | 56 | 360.000 | 1643.34 |
| 15 | 155.000 | 426.65 | 36 | 260.000 | 708.96 | 57 | 365.000 | 1727.25 |
| 16 | 160.000 | 433.68 | 37 | 265.000 | 732.60 | 58 | 370.000 | 1817.14 |
| 17 | 165.000 | 441.47 | 38 | 270.000 | 758.08 | 59 | 375.000 | 1913.16 |
| 18 | 170.000 | 449.87 | 39 | 275.000 | 785.43 | 60 | 380.000 | 2015.94 |
| 19 | 175.000 | 459.01 | 40 | 280.000 | 814.71 | 61 | 385.000 | 2125.62 |
| 20 | 180.000 | 468.83 | 41 | 285.000 | 846.40 | 62 | 390.000 | 2242.89 |
| 21 | 185.000 | 479.37 | 42 | 290.000 | 880.30 | 63 | 395.000 | 2367.68 |

CWE-COM HEATUP CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 60.0

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~418.06~~ | 23 | 195.000 | 445.66 | 44 | 300.000 | 955.79 |
| 2 | 90.000 | ~~412.13~~ | 24 | 200.000 | 456.72 | 45 | 305.000 | 997.79 |
| 3 | 95.000 | ~~399.30~~ | 25 | 205.000 | 468.71 | 46 | 310.000 | 1042.92 |
| 4 | 100.000 | ~~389.32~~ | 26 | 210.000 | 481.53 | 47 | 315.000 | 1091.42 |
| 5 | 105.000 | ~~382.61~~ 370.34 | 27 | 215.000 | 495.50 | 48 | 320.000 | 1143.53 |
| 6 | 110.000 | ~~378.64~~ | 28 | 220.000 | 510.55 | 49 | 325.000 | 1195.16 |
| 7 | 115.000 | ~~373.25~~ | 29 | 225.000 | 526.66 | 50 | 330.000 | 1243.34 |
| 8 | 120.000 | ~~371.16~~ | 30 | 230.000 | 544.13 | 51 | 335.000 | 1294.99 |
| 9 | 125.000 | 370.34 | 31 | 235.000 | 562.93 | 52 | 340.000 | 1350.37 |
| 10 | 130.000 | 370.60 | 32 | 240.000 | 583.04 | 53 | 345.000 | 1409.65 |
| 11 | 135.000 | 371.91 | 33 | 245.000 | 604.82 | 54 | 350.000 | 1473.19 |
| 12 | 140.000 | 374.03 | 34 | 250.000 | 628.07 | 55 | 355.000 | 1541.30 |
| 13 | 145.000 | 376.94 | 35 | 255.000 | 653.24 | 56 | 360.000 | 1614.17 |
| 14 | 150.000 | 380.62 | 36 | 260.000 | 680.14 | 57 | 365.000 | 1692.15 |
| 15 | 155.000 | 385.06 | 37 | 265.000 | 709.18 | 58 | 370.000 | 1775.65 |
| 16 | 160.000 | 390.15 | 38 | 270.000 | 740.30 | 59 | 375.000 | 1864.83 |
| 17 | 165.000 | 395.96 | 39 | 275.000 | 773.67 | 60 | 380.000 | 1960.41 |
| 18 | 170.000 | 402.43 | 40 | 280.000 | 809.51 | 61 | 385.000 | 2062.43 |
| 19 | 175.000 | 409.62 | 41 | 285.000 | 846.40 | 62 | 390.000 | 2171.32 |
| 20 | 180.000 | 417.49 | 42 | 290.000 | 880.30 | 63 | 395.000 | 2287.62 |
| 21 | 185.000 | 426.14 | 43 | 295.000 | 916.70 | 64 | 400.000 | 2411.60 |
| 22 | 190.000 | 435.44 | | | | | | |

CWE-COM HEATUP CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 100.0

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = (1-AOWIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~418.06~~ | 23 | 195.000 | 353.65 | 45 | 305.000 | 772.38 |
| 2 | 90.000 | ~~414.38~~ | 24 | 200.000 | 360.39 | 46 | 310.000 | 812.61 |
| 3 | 95.000 | ~~399.07~~ | 25 | 205.000 | 367.93 | 47 | 315.000 | 855.82 |
| 4 | 100.000 | ~~384.92~~ | 26 | 210.000 | 376.21 | 48 | 320.000 | 902.22 |
| 5 | 105.000 | ~~372.91~~ | 27 | 215.000 | 385.42 | 49 | 325.000 | 952.02 |
| 6 | 110.000 | ~~362.43~~ | 28 | 220.000 | 395.53 | 50 | 330.000 | 1005.48 |
| 7 | 115.000 | ~~353.70~~ 326.64 | 29 | 225.000 | 406.59 | 51 | 335.000 | 1062.86 |
| 8 | 120.000 | ~~340.39~~ | 30 | 230.000 | 418.64 | 52 | 340.000 | 1124.22 |
| 9 | 125.000 | ~~340.43~~ | 31 | 235.000 | 431.67 | 53 | 345.000 | 1189.92 |
| 10 | 130.000 | ~~335.60~~ | 32 | 240.000 | 445.89 | 54 | 350.000 | 1260.48 |
| 11 | 135.000 | ~~331.94~~ | 33 | 245.000 | 461.30 | 55 | 355.000 | 1335.99 |
| 12 | 140.000 | ~~329.24~~ | 34 | 250.000 | 477.86 | 56 | 360.000 | 1416.60 |
| 13 | 145.000 | ~~327.52~~ | 35 | 255.000 | 495.88 | 57 | 365.000 | 1503.30 |
| 14 | 150.000 | ~~326.85~~ | 36 | 260.000 | 515.33 | 58 | 370.000 | 1595.80 |
| 15 | 155.000 | 326.64 | 37 | 265.000 | 536.18 | 59 | 375.000 | 1694.38 |
| 16 | 160.000 | 327.41 | 38 | 270.000 | 558.79 | 60 | 380.000 | 1800.24 |
| 17 | 165.000 | 328.97 | 39 | 275.000 | 583.00 | 61 | 385.000 | 1913.09 |
| 18 | 170.000 | 331.25 | 40 | 280.000 | 609.20 | 62 | 390.000 | 2033.44 |
| 19 | 175.000 | 334.28 | 41 | 285.000 | 637.26 | 63 | 395.000 | 2157.01 |
| 20 | 180.000 | 338.03 | 42 | 290.000 | 667.42 | 64 | 400.000 | 2264.75 |
| 21 | 185.000 | 342.52 | 43 | 295.000 | 700.04 | 65 | 405.000 | 2379.51 |
| 22 | 190.000 | 347.68 | 44 | 300.000 | 734.92 | | | |

A10

CWE-COM 20 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE CALCULATEDFOR THE INSERVICE HYDROSTATIC LEAK TEST

MINIMUM INSERVICE LEAK TEST TEMPERATURE ( 25.000 EFPY)

| PRESSURE (PSI) | TEMPERATURE (DEG.F) |
|---|---|
| 2000 | 357 |
| 2485 | 377 |

| PRESSURE (PSI) | PRESSURE STRESS (PSI) | 1.5 KIM (PSI SQ RT IN.) |
|---|---|---|
| 2000 | 22234 | 92837 |
| 2485 | 27468 | 115765 |

CWE-COM 20 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 20.0

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = (1-AOWIN)T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~414.68~~ | 409.15 | 23 | 195.000 | 499.69 | 45 | 305.000 | 916.70 |
| 2 | 90.000 | ~~411.00~~ | | 24 | 200.000 | 507.72 | 46 | 310.000 | 955.79 |
| 3 | 95.000 | ~~409.63~~ | | 25 | 205.000 | 516.36 | 47 | 315.000 | 997.79 |
| 4 | 100.000 | 409.15 | | 26 | 210.000 | 525.52 | 48 | 320.000 | 1042.92 |
| 5 | 105.000 | 411.28 | | 27 | 215.000 | 535.50 | 49 | 325.000 | 1091.42 |
| 6 | 110.000 | 413.90 | | 28 | 220.000 | 546.23 | 50 | 330.000 | 1142.41 |
| 7 | 115.000 | 417.47 | | 29 | 225.000 | 557.77 | 51 | 335.000 | 1194.34 |
| 8 | 120.000 | 421.39 | | 30 | 230.000 | 570.03 | 52 | 340.000 | 1250.03 |
| 9 | 125.000 | 425.87 | | 31 | 235.000 | 583.37 | 53 | 345.000 | 1309.70 |
| 10 | 130.000 | 430.58 | | 32 | 240.000 | 597.71 | 54 | 350.000 | 1373.53 |
| 11 | 135.000 | 435.85 | | 33 | 245.000 | 613.09 | 55 | 355.000 | 1442.29 |
| 12 | 140.000 | 441.06 | | 34 | 250.000 | 629.53 | 56 | 360.000 | 1515.73 |
| 13 | 145.000 | 444.68 | | 35 | 255.000 | 647.34 | 57 | 365.000 | 1594.64 |
| 14 | 150.000 | 448.57 | | 36 | 260.000 | 666.30 | 58 | 370.000 | 1679.08 |
| 15 | 155.000 | 452.76 | | 37 | 265.000 | 686.89 | 59 | 375.000 | 1769.41 |
| 16 | 160.000 | 457.26 | | 38 | 270.000 | 708.96 | 60 | 380.000 | 1866.13 |
| 17 | 165.000 | 462.10 | | 39 | 275.000 | 732.60 | 61 | 385.000 | 1969.64 |
| 18 | 170.000 | 467.30 | | 40 | 280.000 | 758.08 | 62 | 390.000 | 2080.23 |
| 19 | 175.000 | 472.89 | | 41 | 285.000 | 785.43 | 63 | 395.000 | 2198.29 |
| 20 | 180.000 | 478.80 | | 42 | 290.000 | 814.71 | 64 | 400.000 | 2324.45 |
| 21 | 185.000 | 485.26 | | 43 | 295.000 | 846.40 | 65 | 405.000 | 2458.94 |
| 22 | 190.000 | 492.21 | | 44 | 300.000 | 880.30 | | | |

CWE-COM 40 DEG-F/HR HEATUP REG GUIDE 1.99,REV 2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 40.0

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = (1-AOWIN)T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~414.88~~ | 23 | 195.000 | 480.60 | 45 | 305.000 | 916.70 |
| 2 | 90.000 | ~~400.85~~ | 24 | 200.000 | 492.20 | 46 | 310.000 | 955.79 |
| 3 | 95.000 | ~~397.24~~ 385.61 | 25 | 205.000 | 504.71 | 47 | 315.000 | 997.79 |
| 4 | 100.000 | ~~391.61~~ | 26 | 210.000 | 518.14 | 48 | 320.000 | 1042.92 |
| 5 | 105.000 | ~~387.49~~ | 27 | 215.000 | 532.51 | 49 | 325.000 | 1091.42 |
| 6 | 110.000 | ~~385.75~~ | 28 | 220.000 | 546.23 | 50 | 330.000 | 1143.53 |
| 7 | 115.000 | 385.61 | 29 | 225.000 | 557.77 | 51 | 335.000 | 1193.11 |
| 8 | 120.000 | 386.52 | 30 | 230.000 | 570.03 | 52 | 340.000 | 1244.90 |
| 9 | 125.000 | 388.47 | 31 | 235.000 | 583.37 | 53 | 345.000 | 1300.31 |
| 10 | 130.000 | 391.13 | 32 | 240.000 | 597.71 | 54 | 350.000 | 1359.75 |
| 11 | 135.000 | 394.55 | 33 | 245.000 | 613.09 | 55 | 355.000 | 1423.33 |
| 12 | 140.000 | 398.52 | 34 | 250.000 | 629.53 | 56 | 360.000 | 1491.67 |
| 13 | 145.000 | 403.12 | 35 | 255.000 | 647.34 | 57 | 365.000 | 1564.75 |
| 14 | 150.000 | 408.21 | 36 | 260.000 | 666.30 | 58 | 370.000 | 1643.08 |
| 15 | 155.000 | 413.89 | 37 | 265.000 | 686.89 | 59 | 375.000 | 1726.91 |
| 16 | 160.000 | 420.07 | 38 | 270.000 | 708.96 | 60 | 380.000 | 1816.71 |
| 17 | 165.000 | 426.86 | 39 | 275.000 | 732.60 | 61 | 385.000 | 1912.64 |
| 18 | 170.000 | 434.09 | 40 | 280.000 | 758.08 | 62 | 390.000 | 2015.31 |
| 19 | 175.000 | 442.06 | 41 | 285.000 | 785.43 | 63 | 395.000 | 2124.88 |
| 20 | 180.000 | 450.63 | 42 | 290.000 | 814.71 | 64 | 400.000 | 2242.04 |
| 21 | 185.000 | 459.92 | 43 | 295.000 | 846.40 | 65 | 405.000 | 2366.93 |
| 22 | 190.000 | 469.91 | 44 | 300.000 | 880.30 | | | |

CWE-COM 60 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG.F/HR) = 60.0

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = (1-A0WIN))

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~414.88~~ | 23 | 195.000 | 426.06 | 45 | 305.000 | 916.70 |
| 2 | 90.000 | ~~406.38~~ | 24 | 200.000 | 435.59 | 46 | 310.000 | 955.79 |
| 3 | 95.000 | ~~393.49~~ | 25 | 205.000 | 446.03 | 47 | 315.000 | 997.79 |
| 4 | 100.000 | ~~383.27~~ | 26 | 210.000 | 457.31 | 48 | 320.000 | 1042.92 |
| 5 | 105.000 | ~~375.72~~ 362.41 | 27 | 215.000 | 469.50 | 49 | 325.000 | 1091.42 |
| 6 | 110.000 | ~~370.14~~ | 28 | 220.000 | 482.53 | 50 | 330.000 | 1143.53 |
| 7 | 115.000 | ~~366.32~~ | 29 | 225.000 | 496.70 | 51 | 335.000 | 1195.42 |
| 8 | 120.000 | ~~363.54~~ | 30 | 230.000 | 511.97 | 52 | 340.000 | 1243.60 |
| 9 | 125.000 | ~~362.68~~ | 31 | 235.000 | 528.29 | 53 | 345.000 | 1295.18 |
| 10 | 130.000 | 362.41 | 32 | 240.000 | 545.98 | 54 | 350.000 | 1350.48 |
| 11 | 135.000 | 363.20 | 33 | 245.000 | 565.02 | 55 | 355.000 | 1409.68 |
| 12 | 140.000 | 364.74 | 34 | 250.000 | 585.38 | 56 | 360.000 | 1473.12 |
| 13 | 145.000 | 367.10 | 35 | 255.000 | 607.42 | 57 | 365.000 | 1541.13 |
| 14 | 150.000 | 370.10 | 36 | 260.000 | 630.95 | 58 | 370.000 | 1613.90 |
| 15 | 155.000 | 373.81 | 37 | 265.000 | 656.41 | 59 | 375.000 | 1691.77 |
| 16 | 160.000 | 378.03 | 38 | 270.000 | 683.62 | 60 | 380.000 | 1775.15 |
| 17 | 165.000 | 382.99 | 39 | 275.000 | 712.84 | 61 | 385.000 | 1864.20 |
| 18 | 170.000 | 388.53 | 40 | 280.000 | 744.45 | 62 | 390.000 | 1959.64 |
| 19 | 175.000 | 394.73 | 41 | 285.000 | 778.22 | 63 | 395.000 | 2061.51 |
| 20 | 180.000 | 401.53 | 42 | 290.000 | 814.46 | 64 | 400.000 | 2170.24 |
| 21 | 185.000 | 409.02 | 43 | 295.000 | 846.40 | 65 | 405.000 | 2286.36 |
| 22 | 190.000 | 417.17 | 44 | 300.000 | 880.30 | 66 | 410.000 | 2410.10 |

CWE-COM 100 DEG-F/HR HEATUP REG GUIDE 1.99,REV 2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 100.0

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = (1-AOWIN):

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 414.68 | | 24 | 200.000 | 343.75 | 46 | 310.000 | 737.81 |
| 2 | 90.000 | 408.88 | | 25 | 205.000 | 350.15 | 47 | 315.000 | 775.65 |
| 3 | 95.000 | 393.31 | | 26 | 210.000 | 357.27 | 48 | 320.000 | 816.29 |
| 4 | 100.000 | 379.06 | | 27 | 215.000 | 365.17 | 49 | 325.000 | 859.93 |
| 5 | 105.000 | 366.91 | | 28 | 220.000 | 373.86 | 50 | 330.000 | 906.78 |
| 6 | 110.000 | 356.25 | 317.19 | 29 | 225.000 | 383.32 | 51 | 335.000 | 957.08 |
| 7 | 115.000 | 347.91 | | 30 | 230.000 | 393.73 | 52 | 340.000 | 1011.05 |
| 8 | 120.000 | 339.75 | | 31 | 235.000 | 405.08 | 53 | 345.000 | 1068.88 |
| 9 | 125.000 | 333.50 | | 32 | 240.000 | 417.41 | 54 | 350.000 | 1130.87 |
| 10 | 130.000 | 328.35 | | 33 | 245.000 | 430.71 | 55 | 355.000 | 1197.24 |
| 11 | 135.000 | 324.32 | | 34 | 250.000 | 445.20 | 56 | 360.000 | 1268.40 |
| 12 | 140.000 | 321.22 | | 35 | 255.000 | 460.88 | 57 | 365.000 | 1344.54 |
| 13 | 145.000 | 319.07 | | 36 | 260.000 | 477.70 | 58 | 370.000 | 1426.05 |
| 14 | 150.000 | 317.72 | | 37 | 265.000 | 495.99 | 59 | 375.000 | 1513.18 |
| 15 | 155.000 | 317.19 | | 38 | 270.000 | 515.70 | 60 | 380.000 | 1606.49 |
| 16 | 160.000 | 317.38 | | 39 | 275.000 | 536.03 | 61 | 385.000 | 1706.41 |
| 17 | 165.000 | 318.32 | | 40 | 280.000 | 559.72 | 62 | 390.000 | 1812.97 |
| 18 | 170.000 | 319.93 | | 41 | 285.000 | 584.22 | 63 | 395.000 | 1926.38 |
| 19 | 175.000 | 322.24 | | 42 | 290.000 | 610.73 | 64 | 400.000 | 2048.08 |
| 20 | 180.000 | 325.20 | | 43 | 295.000 | 639.11 | 65 | 405.000 | 2155.51 |
| 21 | 185.000 | 328.84 | | 44 | 300.000 | 669.59 | 66 | 410.000 | 2262.99 |
| 22 | 190.000 | 333.14 | | 45 | 305.000 | 702.54 | 67 | 415.000 | 2377.46 |
| 23 | 195.000 | 338.14 | | | | | | | |

CWE-COM 20 DEG-F/HR HEATUP REG GUIDE 1 99,REV 2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE CALCULATEDFOR THE INSERVICE HYDROSTATIC LEAK TEST

MINIMUM INSERV.CE LEAK TEST TEMPERATURE ( 32 000 EFPY)

| PRESSURE (PSI) | TEMPERATURE (DEG F) |
|---|---|
| 2000 | 368 |
| 2485 | 389 |

| PRESSURE (PSI) | PRESSURE STRESS (PSI) | 1 5 K1M (PSI SQ RT IN ) |
|---|---|---|
| 2000 | 22234 | 92837 |
| 2485 | 27468 | 115765 |

CWE-COM 20 DEG-F/HR HEATUP REG.GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 20.0

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~411.42~~ | 24 | 200.000 | 490.47 | 46 | 310.000 | 871.77 |
| 2 | 90.000 | ~~405.80~~ 402.40 | 25 | 205.000 | 497.81 | 47 | 315.000 | 907.50 |
| 3 | 95.000 | ~~403.29~~ | 26 | 210.000 | 505.71 | 48 | 320.000 | 946.08 |
| 4 | 100.000 | 402.40 | 27 | 215.000 | 514.19 | 49 | 325.000 | 987.40 |
| 5 | 105.000 | 404.07 | 28 | 220.000 | 523.19 | 50 | 330.000 | 1031.76 |
| 6 | 110.000 | 406.17 | 29 | 225.000 | 533.00 | 51 | 335.000 | 1079.43 |
| 7 | 115.000 | 409.18 | 30 | 230.000 | 543.54 | 52 | 340.000 | 1130.54 |
| 8 | 120.000 | 412.49 | 31 | 235.000 | 554.88 | 53 | 345.000 | 1181.26 |
| 9 | 125.000 | 416.30 | 32 | 240.000 | 567.05 | 54 | 350.000 | 1236.01 |
| 10 | 130.000 | 420.38 | 33 | 245.000 | 580.03 | 55 | 355.000 | 1294.75 |
| 11 | 135.000 | 424.90 | 34 | 250.000 | 594.11 | 56 | 360.000 | 1357.60 |
| 12 | 140.000 | 429.62 | 35 | 255.000 | 609.24 | 57 | 365.000 | 1424.99 |
| 13 | 145.000 | 434.88 | 36 | 260.000 | 625.37 | 58 | 370.000 | 1497.32 |
| 14 | 150.000 | 440.22 | 37 | 265.000 | 642.87 | 59 | 375.000 | 1574.74 |
| 15 | 155.000 | 443.77 | 38 | 270.000 | 661.65 | 60 | 380.000 | 1657.70 |
| 16 | 160.000 | 447.60 | 39 | 275.000 | 681.73 | 61 | 385.000 | 1746.44 |
| 17 | 165.000 | 451.71 | 40 | 280.000 | 703.43 | 62 | 390.000 | 1841.60 |
| 18 | 170.000 | 456.13 | 41 | 285.000 | 726.63 | 63 | 395.000 | 1943.31 |
| 19 | 175.000 | 460.89 | 42 | 290.000 | 751.72 | 64 | 400.000 | 2052.16 |
| 20 | 180.000 | 466.00 | 43 | 295.000 | 778.54 | 65 | 405.000 | 2168.38 |
| 21 | 185.000 | 471.49 | 44 | 300.000 | 807.30 | 66 | 410.000 | 2292.42 |
| 22 | 190.000 | 477.29 | 45 | 305.000 | 838.49 | 67 | 415.000 | 2424.65 |
| 23 | 195.000 | 483.64 | | | | | | |

CWE-COM 40 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 40.0

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~411.42~~ | 24 | 200.000 | 467.88 | 47 | 315.000 | 907.50 |
| 2 | 90.000 | ~~400.58~~ | 25 | 205.000 | 478.48 | 48 | 320.000 | 946.08 |
| 3 | 95.000 | ~~391.20~~ 378.14 | 26 | 210.000 | 489.98 | 49 | 325.000 | 987.40 |
| 4 | 100.000 | ~~384.78~~ | 27 | 215.000 | 502.38 | 50 | 330.000 | 1031.76 |
| 5 | 105.000 | ~~380.85~~ | 28 | 220.000 | 515.70 | 51 | 335.000 | 1079.43 |
| 6 | 110.000 | ~~378.70~~ | 29 | 225.000 | 529.93 | 52 | 340.000 | 1130.61 |
| 7 | 115.000 | 378.14 | 30 | 230.000 | 543.54 | 53 | 345.000 | 1181.10 |
| 8 | 120.000 | 378.57 | 31 | 235.000 | 554.88 | 54 | 350.000 | 1231.93 |
| 9 | 125.000 | 379.98 | 32 | 240.000 | 567.05 | 55 | 355.000 | 1286.46 |
| 10 | 130.000 | 382.05 | 33 | 245.000 | 580.03 | 56 | 360.000 | 1344.89 |
| 11 | 135.000 | 384.83 | 34 | 250.000 | 594.11 | 57 | 365.000 | 1407.47 |
| 12 | 140.000 | 388.09 | 35 | 255.000 | 609.24 | 58 | 370.000 | 1474.50 |
| 13 | 145.000 | 391.94 | 36 | 260.000 | 625.37 | 59 | 375.000 | 1546.26 |
| 14 | 150.000 | 396.22 | 37 | 265.000 | 642.87 | 60 | 380.000 | 1623.28 |
| 15 | 155.000 | 401.03 | 38 | 270.000 | 661.65 | 61 | 385.000 | 1705.62 |
| 16 | 160.000 | 406.26 | 39 | 275.000 | 681.73 | 62 | 390.000 | 1793.69 |
| 17 | 165.000 | 412.03 | 40 | 280.000 | 703.43 | 63 | 395.000 | 1888.03 |
| 18 | 170.000 | 418.26 | 41 | 285.000 | 726.63 | 64 | 400.000 | 1988.87 |
| 19 | 175.000 | 425.05 | 42 | 290.000 | 751.72 | 65 | 405.000 | 2096.68 |
| 20 | 180.000 | 432.28 | 43 | 295.000 | 778.54 | 66 | 410.000 | 2211.77 |
| 21 | 185.000 | 440.21 | 44 | 300.000 | 807.30 | 67 | 415.000 | 2334.70 |
| 22 | 190.000 | 448.74 | 45 | 305.000 | 838.49 | 68 | 420.000 | 2465.52 |
| 23 | 195.000 | 457.96 | 46 | 310.000 | 871.77 | | | |

CWE-COM 60 DEG-F/HR HEATUP REG GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 60.0

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 414.42 | 24 | 200.000 | 414.37 | 47 | 315.000 | 907.50 |
| 2 | 90.000 | 400.60 | 25 | 205.000 | 423.25 | 48 | 320.000 | 946.08 |
| 3 | 95.000 | 387.52 | 26 | 210.000 | 432.77 | 49 | 325.000 | 987.40 |
| 4 | 100.000 | 377.47 | 27 | 215.000 | 443.16 | 50 | 330.000 | 1031.76 |
| 5 | 105.000 | 368.46 | 28 | 220.000 | 454.37 | 51 | 335.000 | 1079.43 |
| 6 | 110.000 | 383.51 | 29 | 225.000 | 466.47 | 52 | 340.000 | 1130.61 |
| 7 | 115.000 | 359.35 | 30 | 230.000 | 479.40 | 53 | 345.000 | 1184.42 |
| 8 | 120.000 | 356.45 | 31 | 235.000 | 493.46 | 54 | 350.000 | 1241.69 |
| 9 | 125.000 | 354.84 | 32 | 240.000 | 508.59 | 55 | 355.000 | 1282.37 |
| 10 | 130.000 | 354.14 | 33 | 245.000 | 524.76 | 56 | 360.000 | 1336.78 |
| 11 | 135.000 | 354.41 | 34 | 250.000 | 542.29 | 57 | 365.000 | 1394.88 |
| 12 | 140.000 | 355.38 | 35 | 255.000 | 561.16 | 58 | 370.000 | 1457.24 |
| 13 | 145.000 | 357.11 | 36 | 260.000 | 581.30 | 59 | 375.000 | 1523.90 |
| 14 | 150.000 | 359.42 | 37 | 265.000 | 603.13 | 60 | 380.000 | 1595.42 |
| 15 | 155.000 | 362.39 | 38 | 270.000 | 626.42 | 61 | 385.000 | 1671.85 |
| 16 | 160.000 | 365.89 | 39 | 275.000 | 651.64 | 62 | 390.000 | 1753.69 |
| 17 | 165.000 | 369.98 | 40 | 280.000 | 678.56 | 63 | 395.000 | 1841.24 |
| 18 | 170.000 | 374.59 | 41 | 285.000 | 707.64 | 64 | 400.000 | 1934.94 |
| 19 | 175.000 | 379.71 | 42 | 290.000 | 738.79 | 65 | 405.000 | 2035.11 |
| 20 | 180.000 | 385.43 | 43 | 295.000 | 772.19 | 66 | 410.000 | 2141.88 |
| 21 | 185.000 | 391.76 | 44 | 300.000 | 807.30 | 67 | 415.000 | 2255.91 |
| 22 | 190.000 | 398.65 | 45 | 305.000 | 838.49 | 68 | 420.000 | 2377.72 |
| 23 | 195.000 | 406.19 | 46 | 310.000 | 871.77 | | | |

CWE-COM 100 DEG-F/HR HEATUP REG GUIDE 1.99,REV 2 WITH MARGIN 05/15/92

COMPOSITE CURVE PLOTTED FOR HEATUP PROFILE 2 HEATUP RATE(S) (DEG F/HR) = 100.0

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = (1-A0WIN)T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | ~~411.42~~ | 25 | 205.000 | 332.28 | 48 | 320.000 | 729.46 |
| 2 | 90.000 | ~~409.14~~ | 26 | 210.000 | 338.16 | 49 | 325.000 | 766.87 |
| 3 | 95.000 | ~~387.50~~ | 27 | 215.000 | 344.67 | 50 | 330.000 | 807.03 |
| 4 | 100.000 | ~~379.22~~ | 28 | 220.000 | 351.92 | 51 | 335.000 | 850.35 |
| 5 | 105.000 | ~~360.86~~ | 29 | 225.000 | 359.92 | 52 | 340.000 | 896.66 |
| 6 | 110.000 | ~~350.02~~ | 30 | 230.000 | 368.68 | 53 | 345.000 | 946.34 |
| 7 | 115.000 | ~~340.92~~ | 31 | 235.000 | 378.18 | 54 | 350.000 | 999.48 |
| 8 | 120.000 | ~~333.85~~ 307.21 | 32 | 240.000 | 388.61 | 55 | 355.000 | 1056.71 |
| 9 | 125.000 | ~~326.51~~ | 33 | 245.000 | 399.94 | 56 | 360.000 | 1118.02 |
| 10 | 130.000 | ~~321.04~~ | 34 | 250.000 | 412.23 | 57 | 365.000 | 1183.43 |
| 11 | 135.000 | ~~316.65~~ | 35 | 255.000 | 425.55 | 58 | 370.000 | 1253.92 |
| 12 | 140.000 | ~~313.15~~ | 36 | 260.000 | 439.86 | 59 | 375.000 | 1329.09 |
| 13 | 145.000 | ~~310.55~~ | 37 | 265.000 | 455.43 | 60 | 380.000 | 1409.79 |
| 14 | 150.000 | ~~308.71~~ | 38 | 270.000 | 472.23 | 61 | 385.000 | 1496.01 |
| 15 | 155.000 | ~~307.65~~ | 39 | 275.000 | 490.25 | 62 | 390.000 | 1588.24 |
| 16 | 160.000 | 307.27 | 40 | 280.000 | 509.78 | 63 | 395.000 | 1686.88 |
| 17 | 165.000 | 307.58 | 41 | 285.000 | 530.70 | 64 | 400.000 | 1792.08 |
| 18 | 170.000 | 308.52 | 42 | 290.000 | 553.36 | 65 | 405.000 | 1904.74 |
| 19 | 175.000 | 310.09 | 43 | 295.000 | 577.60 | 66 | 410.000 | 2024.59 |
| 20 | 180.000 | 312.26 | 44 | 300.000 | 603.84 | 67 | 415.000 | 2128.83 |
| 21 | 185.000 | 315.05 | 45 | 305.000 | 631.89 | 68 | 420.000 | 2234.28 |
| 22 | 190.000 | 318.43 | 46 | 310.000 | 662.17 | 69 | 425.000 | 2346.59 |
| 23 | 195.000 | 322.43 | 47 | 315.000 | 694.64 | 70 | 430.000 | 2466.70 |
| 24 | 200.000 | 327.03 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 1 ( STEADY-STATE COOLDOWN )

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 424.28 | 21 | 185.000 | 526.04 | 41 | 285.000 | 958.00 |
| 2 | 90.000 | 426.64 | 22 | 190.000 | 536.06 | 42 | 290.000 | 1000.16 |
| 3 | 95.000 | 429.17 | 23 | 195.000 | 546.84 | 43 | 295.000 | 1045.48 |
| 4 | 100.000 | 431.80 | 24 | 200.000 | 558.42 | 44 | 300.000 | 1094.17 |
| 5 | 105.000 | 434.72 | 25 | 205.000 | 570.73 | 45 | 305.000 | 1146.49 |
| 6 | 110.000 | 437.87 | 26 | 210.000 | 584.12 | 46 | 310.000 | 1202.65 |
| 7 | 115.000 | 441.25 | 27 | 215.000 | 598.51 | 47 | 315.000 | 1262.86 |
| 8 | 120.000 | 444.88 | 28 | 220.000 | 613.95 | 48 | 320.000 | 1327.32 |
| 9 | 125.000 | 448.79 | 29 | 225.000 | 630.45 | 49 | 325.000 | 1396.76 |
| 10 | 130.000 | 453.00 | 30 | 230.000 | 648.34 | 50 | 330.000 | 1471.01 |
| 11 | 135.000 | 457.51 | 31 | 235.000 | 667.38 | 51 | 335.000 | 1550.70 |
| 12 | 140.000 | 462.37 | 32 | 240.000 | 688.04 | 52 | 340.000 | 1636.13 |
| 13 | 145.000 | 467.59 | 33 | 245.000 | 710.20 | 53 | 345.000 | 1727.57 |
| 14 | 150.000 | 473.21 | 34 | 250.000 | 733.93 | 54 | 350.000 | 1825.53 |
| 15 | 155.000 | 479.14 | 35 | 255.000 | 759.37 | 55 | 355.000 | 1930.13 |
| 16 | 160.000 | 485.63 | 36 | 260.000 | 786.97 | 56 | 360.000 | 2042.39 |
| 17 | 165.000 | 492.60 | 37 | 265.000 | 816.37 | 57 | 365.000 | 2161.95 |
| 18 | 170.000 | 500.11 | 38 | 270.000 | 848.15 | 58 | 370.000 | 2289.96 |
| 19 | 175.000 | 508.17 | 39 | 275.000 | 882.21 | 59 | 375.000 | 2426.51 |
| 20 | 180.000 | 516.84 | 40 | 280.000 | 918.76 | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 2 ( 20 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = AUWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 381.14 | 16 | 160.000 | 444.08 | 30 | 230.000 | 616.52 |
| 2 | 90.000 | 383.45 | 17 | 165.000 | 451.39 | 31 | 235.000 | 636.93 |
| 3 | 95.000 | 385.97 | 18 | 170.000 | 459.24 | 32 | 240.000 | 658.98 |
| 4 | 100.000 | 388.68 | 19 | 175.000 | 467.72 | 33 | 245.000 | 682.61 |
| 5 | 105.000 | 391.63 | 20 | 180.000 | 476.73 | 34 | 250.000 | 708.12 |
| 6 | 110.000 | 394.79 | 21 | 185.000 | 486.57 | 35 | 255.000 | 735.49 |
| 7 | 115.000 | 398.22 | 22 | 190.000 | 497.14 | 36 | 260.000 | 764.84 |
| 8 | 120.000 | 401.91 | 23 | 195.000 | 508.54 | 37 | 265.000 | 796.65 |
| 9 | 125.000 | 405.92 | 24 | 200.000 | 520.79 | 38 | 270.000 | 830.68 |
| 10 | 130.000 | 410.21 | 25 | 205.000 | 533.90 | 39 | 275.000 | 867.23 |
| 11 | 135.000 | 414.87 | 26 | 210.000 | 548.11 | 40 | 280.000 | 906.52 |
| 12 | 140.000 | 419.88 | 27 | 215.000 | 563.41 | 41 | 285.000 | 948.78 |
| 13 | 145.000 | 425.29 | 28 | 220.000 | 579.74 | 42 | 290.000 | 994.20 |
| 14 | 150.000 | 431.03 | 29 | 225.000 | 597.48 | 43 | 295.000 | 1043.06 |
| 15 | 155.000 | 437.32 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 3 ( 40 DEG F / HR COOLDOWN )

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 337.09 | 16 | 160.000 | 401.82 | 30 | 230.000 | 585.05 |
| 2 | 90.000 | 339.38 | 17 | 165.000 | 409.49 | 31 | 235.000 | 607.05 |
| 3 | 95.000 | 341.90 | 18 | 170.000 | 417.75 | 32 | 240.000 | 630.55 |
| 4 | 100.000 | 344.55 | 19 | 175.000 | 426.69 | 33 | 245.000 | 656.05 |
| 5 | 105.000 | 347.53 | 20 | 180.000 | 436.22 | 34 | 250.000 | 683.31 |
| 6 | 110.000 | 350.73 | 21 | 185.000 | 446.63 | 35 | 255.000 | 712.68 |
| 7 | 115.000 | 354.23 | 22 | 190.000 | 457.83 | 36 | 260.000 | 744.47 |
| 8 | 120.000 | 358.00 | 23 | 195.000 | 469.93 | 37 | 265.000 | 778.53 |
| 9 | 125.000 | 362.11 | 24 | 200.000 | 482.85 | 38 | 270.000 | 815.11 |
| 10 | 130.000 | 366.53 | 25 | 205.000 | 496.91 | 39 | 275.000 | 854.53 |
| 11 | 135.000 | 371.35 | 26 | 210.000 | 512.04 | 40 | 280.000 | 897.09 |
| 12 | 140.000 | 376.46 | 27 | 215.000 | 528.26 | 41 | 285.000 | 942.73 |
| 13 | 145.000 | 382.09 | 28 | 220.000 | 545.83 | 42 | 290.000 | 991.75 |
| 14 | 150.000 | 388.16 | 29 | 225.000 | 564.78 | 43 | 295.000 | 1044.34 |
| 15 | 155.000 | 394.74 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 4 ( 60 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 291.87 | 15 | 155.000 | 351.35 | 29 | 225.000 | 532.35 |
| 2 | 90.000 | 294.14 | 16 | 160.000 | 358.80 | 30 | 230.000 | 554.24 |
| 3 | 95.000 | 296.67 | 17 | 165.000 | 366.88 | 31 | 235.000 | 577.71 |
| 4 | 100.000 | 299.40 | 18 | 170.000 | 375.53 | 32 | 240.000 | 603.14 |
| 5 | 105.000 | 302.36 | 19 | 175.000 | 384.99 | 33 | 245.000 | 630.41 |
| 6 | 110.000 | 305.62 | 20 | 180.000 | 395.18 | 34 | 250.000 | 659.91 |
| 7 | 115.000 | 309.20 | 21 | 185.000 | 406.23 | 35 | 255.000 | 691.61 |
| 8 | 120.000 | 313.07 | 22 | 190.000 | 418.13 | 36 | 260.000 | 725.68 |
| 9 | 125.000 | 317.30 | 23 | 195.000 | 430.92 | 37 | 265.000 | 762.40 |
| 10 | 130.000 | 321.88 | 24 | 200.000 | 444.80 | 38 | 270.000 | 802.10 |
| 11 | 135.000 | 326.88 | 25 | 205.000 | 459.81 | 39 | 275.000 | 844.69 |
| 12 | 140.000 | 332.28 | 26 | 210.000 | 475.87 | 40 | 280.000 | 890.51 |
| 13 | 145.000 | 338.16 | 27 | 215.000 | 493.34 | 41 | 285.000 | 939.83 |
| 14 | 150.000 | 344.45 | 28 | 220.000 | 512.16 | 42 | 290.000 | 992.87 |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 5 ( 100 DEG-F/HR COOLDOWN )

IRRADIATION PERIOD = 14.000 EFP YEARS
FLAW DEPTH = AOWIN I

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 197.76 | 15 | 155.000 | 262.08 | 29 | 225.000 | 469.67 |
| 2 | 90.000 | 200.04 | 16 | 160.000 | 270.42 | 30 | 230.000 | 494.96 |
| 3 | 95.000 | 202.61 | 17 | 165.000 | 279.52 | 31 | 235.000 | 522.31 |
| 4 | 100.000 | 205.42 | 18 | 170.000 | 289.35 | 32 | 240.000 | 551.[illegible] |
| 5 | 105.000 | 208.57 | 19 | 175.000 | 300.08 | 33 | 245.000 | 583.75 |
| 6 | 110.000 | 211.98 | 20 | 180.000 | 311.61 | 34 | 250.000 | 618.05 |
| 7 | 115.000 | 215.80 | 21 | 185.000 | 324.20 | 35 | 255.000 | 655.25 |
| 8 | 120.000 | 219.94 | 22 | 190.000 | 337.79 | 36 | 260.000 | 695.17 |
| 9 | 125.000 | 224.49 | 23 | 195.000 | 352.49 | 37 | 265.000 | 738.23 |
| 10 | 130.000 | 229.46 | 24 | 200.000 | 368.42 | 38 | 270.000 | 784.59 |
| 11 | 135.000 | 234.93 | 25 | 205.000 | 385.62 | 39 | 275.000 | 834.55 |
| 12 | 140.000 | 240.86 | 26 | 210.000 | 404.25 | 40 | 280.000 | 888.33 |
| 13 | 145.000 | 247.37 | 27 | 215.000 | 424.43 | 41 | 285.000 | 946.22 |
| 14 | 150.000 | 254.41 | 28 | 220.000 | 446.11 | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 1 ( STEADY-STATE COOLDOWN )

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 418.06 | 22 | 190.000 | 507.72 | 43 | 295.000 | 916.70 |
| 2 | 90.000 | 419.85 | 23 | 195.000 | 516.36 | 44 | 300.000 | 955.79 |
| 3 | 95.000 | 421.98 | 24 | 200.000 | 525.52 | 45 | 305.000 | 997.79 |
| 4 | 100.000 | 424.16 | 25 | 205.000 | 535.50 | 46 | 310.000 | 1042.92 |
| 5 | 105.000 | 426.50 | 26 | 210.000 | 546.23 | 47 | 315.000 | 1091.42 |
| 6 | 110.000 | 429.03 | 27 | 215.000 | 557.77 | 48 | 320.000 | 1143.53 |
| 7 | 115.000 | 431.65 | 28 | 220.000 | 570.03 | 49 | 325.000 | 1199.53 |
| 8 | 120.000 | 434.56 | 29 | 225.000 | 583.37 | 50 | 330.000 | 1259.51 |
| 9 | 125.000 | 437.69 | 30 | 230.000 | 597.71 | 51 | 335.000 | 1323.66 |
| 10 | 130.000 | 441.06 | 31 | 235.000 | 613.09 | 52 | 340.000 | 1392.91 |
| 11 | 135.000 | 444.68 | 32 | 240.000 | 629.53 | 53 | 345.000 | 1466.78 |
| 12 | 140.000 | 448.57 | 33 | 245.000 | 647.34 | 54 | 350.000 | 1546.26 |
| 13 | 145.000 | 452.76 | 34 | 250.000 | 666.30 | 55 | 355.000 | 1631.37 |
| 14 | 150.000 | 457.26 | 35 | 255.000 | 686.89 | 56 | 360.000 | 1722.46 |
| 15 | 155.000 | 462.10 | 36 | 260.000 | 708.96 | 57 | 365.000 | 1820.05 |
| 16 | 160.000 | 467.30 | 37 | 265.000 | 732.60 | 58 | 370.000 | 1924.40 |
| 17 | 165.000 | 472.89 | 38 | 270.000 | 758.08 | 59 | 375.000 | 2036.09 |
| 18 | 170.000 | 478.80 | 39 | 275.000 | 785.43 | 60 | 380.000 | 2155.39 |
| 19 | 175.000 | 485.26 | 40 | 280.000 | 814.71 | 61 | 385.000 | 2282.94 |
| 20 | 180.000 | 492.21 | 41 | 285.000 | 846.40 | 62 | 390.000 | 2418.76 |
| 21 | 185.000 | 499.69 | 42 | 290.000 | 880.30 | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 2 ( 20 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 374.57 | 17 | 165.000 | 430.15 | 32 | 240.000 | 596.02 |
| 2 | 90.000 | 376.31 | 18 | 170.000 | 436.39 | 33 | 245.000 | 615.02 |
| 3 | 95.000 | 378.29 | 19 | 175.000 | 443.15 | 34 | 250.000 | 635.34 |
| 4 | 100.000 | 380.42 | 20 | 180.000 | 450.41 | 35 | 255.000 | 657.34 |
| 5 | 105.000 | 382.74 | 21 | 185.000 | 458.26 | 36 | 260.000 | 680.87 |
| 6 | 110.000 | 385.24 | 22 | 190.000 | 466.69 | 37 | 265.000 | 706.33 |
| 7 | 115.000 | 387.95 | 23 | 195.000 | 475.69 | 38 | 270.000 | 733.58 |
| 8 | 120.000 | 390.87 | 24 | 200.000 | 485.47 | 39 | 275.000 | 762.85 |
| 9 | 125.000 | 394.04 | 25 | 205.000 | 496.03 | 40 | 280.000 | 794.54 |
| 10 | 130.000 | 397.44 | 26 | 210.000 | 507.36 | 41 | 285.000 | 828.47 |
| 11 | 135.000 | 401.14 | 27 | 215.000 | 519.60 | 42 | 290.000 | 864.89 |
| 12 | 140.000 | 405.11 | 28 | 220.000 | 532.64 | 43 | 295.000 | 904.07 |
| 13 | 145.000 | 409.41 | 29 | 225.000 | 546.83 | 44 | 300.000 | 946.37 |
| 14 | 150.000 | 414.03 | 30 | 230.000 | 562.07 | 45 | 305.000 | 991.68 |
| 15 | 155.000 | 419.04 | 31 | 235.000 | 578.36 | 46 | 310.000 | 1040.34 |
| 16 | 160.000 | 424.41 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 3 ( 40 DEG F / HR COOLDOWN )

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 329.99 | 17 | 165.000 | 386.39 | 32 | 240.000 | 562.79 |
| 2 | 90.000 | 331.74 | 18 | 170.000 | 393.22 | 33 | 245.000 | 583.04 |
| 3 | 95.000 | 333.68 | 19 | 175.000 | 400.40 | 34 | 250.000 | 604.95 |
| 4 | 100.000 | 335.77 | 20 | 180.000 | 407.93 | 35 | 255.000 | 628.42 |
| 5 | 105.000 | 338.08 | 21 | 185.000 | 416.19 | 36 | 260.000 | 653.82 |
| 6 | 110.000 | 340.56 | 22 | 190.000 | 425.08 | 37 | 265.000 | 681.05 |
| 7 | 115.000 | 343.23 | 23 | 195.000 | 434.61 | 38 | 270.000 | 710.46 |
| 8 | 120.000 | 346.17 | 24 | 200.000 | 444.96 | 39 | 275.000 | 742.08 |
| 9 | 125.000 | 349.38 | 25 | 205.000 | 456.16 | 40 | 280.000 | 775.99 |
| 10 | 130.000 | 352.84 | 26 | 210.000 | 468.20 | 41 | 285.000 | 812.53 |
| 11 | 135.000 | 356.62 | 27 | 215.000 | 481.11 | 42 | 290.000 | 851.98 |
| 12 | 140.000 | 360.69 | 28 | 220.000 | 495.10 | 43 | 295.000 | 894.30 |
| 13 | 145.000 | 365.13 | 29 | 225.000 | 510.23 | 44 | 300.000 | 939.78 |
| 14 | 150.000 | 369.90 | 30 | 230.000 | 526.37 | 45 | 305.000 | 988.76 |
| 15 | 155.000 | 375.10 | 31 | 235.000 | 543.92 | 46 | 310.000 | 1041.14 |
| 16 | 160.000 | 380.62 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 4 ( 60 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 284.26 | 16 | 160.000 | 336.07 | 31 | 235.000 | 509.72 |
| 2 | 90.000 | 285.96 | 17 | 165.000 | 342.42 | 32 | 240.000 | 529.85 |
| 3 | 95.000 | 287.86 | 18 | 170.000 | 349.22 | 33 | 245.000 | 551.72 |
| 4 | 100.000 | 289.92 | 19 | 175.000 | 356.68 | 34 | 250.000 | 575.12 |
| 5 | 105.000 | 292.22 | 20 | 180.000 | 364.72 | 35 | 255.000 | 600.54 |
| 6 | 110.000 | 294.70 | 21 | 185.000 | 373.45 | 36 | 260.000 | 627.73 |
| 7 | 115.000 | 297.45 | 22 | 190.000 | 382.78 | 37 | 265.000 | 657.21 |
| 8 | 120.000 | 300.42 | 23 | 195.000 | 392.98 | 38 | 270.000 | 688.82 |
| 9 | 125.000 | 303.65 | 24 | 200.000 | 403.97 | 39 | 275.000 | 722.86 |
| 10 | 130.000 | 307 .9 | 25 | 205.000 | 415.88 | 40 | 280.000 | 759.48 |
| 11 | 135.000 | 311.07 | 26 | 210.000 | 428.71 | 41 | 285.000 | 799.15 |
| 12 | 140.000 | 315.27 | 27 | 215.000 | 442.50 | 42 | 290.000 | 841.66 |
| 13 | 145.000 | 319.86 | 28 | 220.000 | 457.45 | 43 | 295.000 | 887.44 |
| 14 | 150.000 | 324.82 | 29 | 225.000 | 473.61 | 44 | 300.000 | 936.64 |
| 15 | 155.000 | 330.23 | 30 | 230.000 | 490.91 | 45 | 305.000 | 989.64 |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 5 ( 100 DEG F/HR COOLDOWN )

IRRADIATION PERIOD = 20.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 189.00 | 16 | 160.000 | 244.02 | 31 | 235.000 | 442.76 |
| 2 | 90.000 | 190.61 | 17 | 165.000 | 251.10 | 32 | 240.000 | 466.28 |
| 3 | 95.000 | 192.46 | 18 | 170.000 | 258.76 | 33 | 245.000 | 491.61 |
| 4 | 100.000 | 194.50 | 19 | 175.000 | 267.10 | 34 | 250.000 | 519.02 |
| 5 | 105.000 | 196.81 | 20 | 180.000 | 276.16 | 35 | 255.000 | 548.55 |
| 6 | 110.000 | 199.33 | 21 | 185.000 | 286.03 | 36 | [illegible]0 | 580.35 |
| 7 | 115.000 | 202.17 | 22 | 190.000 | 296.70 | 37 | 265.000 | 614.82 |
| 8 | 120.000 | 205.27 | 23 | 195.000 | 308.27 | 38 | 270.000 | 651.85 |
| 9 | 125.000 | 208.73 | 24 | 200.000 | 320.81 | 39 | [illegible]0 | 691.79 |
| 10 | 130.000 | 212.49 | 25 | 205.000 | 334.45 | 40 | [illegible]0 | 734.79 |
| 11 | 135.000 | 216.66 | 26 | 210.000 | 349.10 | 41 | [illegible]000 | 781.17 |
| 12 | 140.000 | 221.17 | 27 | 215.000 | 365.07 | 42 | [illegible]000 | 831.09 |
| 13 | 145.000 | 226.17 | 28 | 220.000 | 382.23 | 43 | [illegible]00 | 884.85 |
| 14 | 150.000 | 231.59 | 29 | 225.000 | 400.90 | 44 | [illegible]30 | 942.68 |
| 15 | 155.000 | 237.56 | 30 | 230.000 | 421.04 | | | |

A30

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 1 ( STEADY-STATE COOLDOWN )

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 414.68 | 23 | 195.000 | 499.69 | 44 | 300.000 | 880.30 |
| 2 | 90.000 | 416.31 | 24 | 200.000 | 507.72 | 45 | 305.000 | 916.70 |
| 3 | 95.000 | 418.06 | 25 | 205.000 | 516.36 | 46 | 310.000 | 955.79 |
| 4 | 100.000 | 419.95 | 26 | 210.000 | 525.52 | 47 | 315.000 | 997.79 |
| 5 | 105.000 | 421.98 | 27 | 215.000 | 535.50 | 48 | 320.000 | 1042.92 |
| 6 | 110.000 | 424.16 | 28 | 220.000 | 546.23 | 49 | 325.000 | 1091.42 |
| 7 | 115.000 | 426.50 | 29 | 225.000 | 557.77 | 50 | 330.000 | 1143.53 |
| 8 | 120.000 | 429.03 | 30 | 230.000 | 570.03 | 51 | 335.000 | 1199.53 |
| 9 | 125.000 | 43*.65 | 31 | 235.000 | 583.37 | 52 | 340.000 | 1259.51 |
| 10 | 130.000 | 434.56 | 32 | 240.000 | 597.71 | 53 | 345.000 | 1323.66 |
| 11 | 135.000 | 437.69 | 33 | 245.000 | 613.09 | 54 | 350.000 | 1392.91 |
| 12 | 140.000 | 441.06 | 34 | 250.000 | 629.53 | 55 | 355.000 | 1466.78 |
| 13 | 145.000 | 444.68 | 35 | 255.000 | 647.34 | 56 | 360.000 | 1546.26 |
| 14 | 150.000 | 448.57 | 36 | 260.000 | 666.30 | 57 | 365.000 | 1631.37 |
| 15 | 155.000 | 452.76 | 37 | 265.000 | 686.89 | 58 | 370.000 | 1722.46 |
| 16 | 160.000 | 457.26 | 38 | 270.000 | 708.96 | 59 | 375.000 | 1820.05 |
| 17 | 165.000 | 462.10 | 39 | 275.000 | 732.60 | 60 | 380.000 | 1924.40 |
| 18 | 170.000 | 467.30 | 40 | 280.000 | 758.08 | 61 | 385.000 | 2036.09 |
| 19 | 175.000 | 472.89 | 41 | 285.000 | 785.43 | 62 | 390.000 | 2155.39 |
| 20 | 180.000 | 478.80 | 42 | 290.000 | 814.71 | 63 | 395.000 | 2282.94 |
| 21 | 185.000 | 485.26 | 43 | 295.000 | 846.40 | 64 | 400.000 | 2418.76 |
| 22 | 190.000 | 492.21 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 2 ( 20 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = ADWIN 1

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 370.95 | 17 | 165.000 | 418.66 | 33 | 245.000 | 578.05 |
| 2 | 90.000 | 372.49 | 18 | 170.000 | 424.04 | 34 | 250.000 | 595.72 |
| 3 | 95.000 | 374.18 | 19 | 175.000 | 429.77 | 35 | 255.000 | 614.72 |
| 4 | 100.000 | 375.92 | 20 | 180.000 | 436.02 | 36 | 260.000 | 635.05 |
| 5 | 105.000 | 377.91 | 21 | 185.000 | 442.79 | 37 | 265.000 | 657.08 |
| 6 | 110.000 | 380.04 | 22 | 190.000 | 450.05 | 38 | 270.000 | 680.60 |
| 7 | 115.000 | 382.36 | 23 | 195.000 | 457.90 | 39 | 275.000 | 706.08 |
| 8 | 120.000 | 384.85 | 24 | 200.000 | 466.33 | 40 | 280.000 | 733.34 |
| 9 | 125.000 | 387.57 | 25 | 205.000 | 475.34 | 41 | 285.000 | 762.63 |
| 10 | 130.000 | 390.48 | 26 | 210.000 | 485.12 | 42 | 290.000 | 794.43 |
| 11 | 135.000 | 39.. 66 | 27 | 215.000 | 495.68 | 43 | 295.000 | 828.28 |
| 12 | 140.000 | 397.06 | 28 | 220.000 | 507.03 | 44 | 300.000 | 864.72 |
| 13 | 145.000 | 400.76 | 29 | 225.000 | 519.27 | 45 | 305.000 | 903.91 |
| 14 | 150.000 | 404.72 | 30 | 230.000 | 532.31 | 46 | 310.000 | 946.23 |
| 15 | 155.000 | 409.03 | 31 | 235.000 | 546.50 | 47 | 315.000 | 991.56 |
| 16 | 160.000 | 413.55 | 32 | 240.000 | 561.75 | 48 | 320.000 | 1040.25 |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 3 ( 40 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 326.12 | 17 | 165.000 | 374.34 | 33 | 245.000 | 543.30 |
| 2 | 90.000 | 327.58 | 18 | 170.000 | 379.86 | 34 | 250.000 | 562.20 |
| 3 | 95.000 | 329.21 | 19 | 175.000 | 385.93 | 35 | 255.000 | 582.46 |
| 4 | 100.000 | 330.96 | 20 | 180.000 | 392.47 | 36 | 260.000 | 604.33 |
| 5 | 105.000 | 332.90 | 21 | 185.000 | 399.56 | 37 | 265.000 | 627.88 |
| 6 | 110.000 | 334.99 | 22 | 190.000 | 407.19 | 38 | 270.000 | 653.30 |
| 7 | 115.000 | 337.30 | 23 | 195.000 | 415.46 | 39 | 275.000 | 680.57 |
| 8 | 120.000 | 339.78 | 24 | 200.000 | 424.36 | 40 | 280.000 | 710.00 |
| 9 | 125.000 | 342.51 | 25 | 205.000 | 433.90 | 41 | 285.000 | 741.65 |
| 10 | 130.000 | 345.39 | 26 | 210.000 | 444.25 | 42 | 290.000 | 775.59 |
| 11 | 135.000 | 348.60 | 27 | 215.000 | 455.46 | 43 | 295.000 | 812.17 |
| 12 | 140.000 | 352.07 | 28 | 220.000 | 467.51 | 44 | 300.000 | 851.66 |
| 13 | 145.000 | 355.85 | 29 | 225.000 | 480.43 | 45 | 305.000 | 894.02 |
| 14 | 150.000 | 359.92 | 30 | 230.000 | 494.44 | 46 | 310.000 | 939.55 |
| 15 | 155.000 | 364.36 | 31 | 235.000 | 509.58 | 47 | 315.000 | 988.58 |
| 16 | 160.000 | 369.04 | 32 | 240.000 | 525.73 | 48 | 320.000 | 1041.00 |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 4 ( 60 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 280.12 | 17 | 165.000 | 329.07 | 33 | 245.000 | 508.80 |
| 2 | 90.000 | 281.51 | 18 | 170.000 | 334.91 | 34 | 250.000 | 528.96 |
| 3 | 95.000 | 283.07 | 19 | 175.000 | 341.28 | 35 | 255.000 | 550.86 |
| 4 | 100.000 | 284.77 | 20 | 180.000 | 348.09 | 36 | 260.000 | 574.30 |
| 5 | 105.000 | 286.67 | 21 | 185.000 | 355.55 | 37 | 265.000 | 599.75 |
| 6 | 110.000 | 288.73 | 22 | 190.000 | 363.60 | 38 | 270.000 | 626.98 |
| 7 | 115.000 | 291.02 | 23 | 195.000 | 372.34 | 39 | 275.000 | 656.52 |
| 8 | 120.000 | 293.51 | 24 | 200.000 | 381.69 | 40 | 280.000 | 688.16 |
| 9 | 125.000 | 296.26 | 25 | 205.000 | 391.90 | 41 | 285.000 | 722.26 |
| 10 | 130.000 | 299.23 | 26 | 210.000 | 402.91 | 42 | 290.000 | 758.93 |
| 11 | 135.000 | 302.46 | 27 | 215.000 | 414.83 | 43 | 295.000 | 798.66 |
| 12 | 140.000 | 306.01 | 28 | 220.000 | 427.67 | 44 | 300.000 | 841.23 |
| 13 | 145.000 | 309.90 | 29 | 225.000 | 441.48 | 45 | 305.000 | 887.08 |
| 14 | 150.000 | 314.10 | 30 | 230.000 | 456.45 | 46 | 310.000 | 936.36 |
| 15 | 155.000 | 318.69 | 31 | 235.000 | 472.64 | 47 | 315.000 | 989.44 |
| 16 | 160.000 | 323.65 | 32 | 240.000 | 489.97 | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 5 ( 100 DEG-F/HR COOLDOWN )

IRRADIATION PERIOD = 25.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 184.23 | 17 | 165.000 | 235.59 | 32 | 240.000 | 419.59 |
| 2 | 90.000 | 185.48 | 18 | 170.000 | 242.07 | 33 | 245.000 | 441.37 |
| 3 | 95.000 | 186.94 | 19 | 175.000 | 249.17 | 34 | 250.000 | 464.95 |
| 4 | 100.000 | 188.55 | 20 | 180.000 | 256.86 | 35 | 255.000 | 490.36 |
| 5 | 105.000 | 190.40 | 21 | 185.000 | 265.22 | 36 | 260.000 | 517.85 |
| 6 | 110.000 | 192.44 | 22 | 190.000 | 274.30 | 37 | 265.000 | 547.45 |
| 7 | 115.000 | 194.75 | 23 | 195.000 | 284.20 | 38 | 270.000 | 579.33 |
| 8 | 120.000 | 197.28 | 24 | 200.000 | 294.90 | 39 | 275.000 | 613.89 |
| 9 | 125.000 | 200.13 | 25 | 205.000 | 306.50 | 40 | 280.000 | 651.02 |
| 10 | 130.000 | 203.23 | 26 | 210.000 | 319.08 | 41 | 285.000 | 691.06 |
| 11 | 135.000 | 206.70 | 27 | 215.000 | 332.75 | 42 | 290.000 | 734.16 |
| 12 | 140.000 | 210.47 | 28 | 220.000 | 347.45 | 43 | 295.000 | 780.64 |
| 13 | 145.000 | 214.65 | 29 | 225.000 | 363.46 | 44 | 300.000 | 830.68 |
| 14 | 150.000 | 219.19 | 30 | 230.000 | 380.66 | 45 | 305.000 | 884.55 |
| 15 | 155.000 | 224.18 | 31 | 235.000 | 399.39 | 46 | 310.000 | 942.50 |
| 16 | 160.000 | 229.62 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN

05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 1 ( STEADY-STATE COOLDOWN )

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 411.42 | 23 | 195.000 | 483.64 | 45 | 305.000 | 838.49 |
| 2 | 90.000 | 412.81 | 24 | 200.000 | 490.47 | 46 | 310.000 | 871.77 |
| 3 | 95.000 | 414.30 | 25 | 205.000 | 497.81 | 47 | 315.000 | 907.50 |
| 4 | 100.000 | 415.90 | 26 | 210.000 | 505.71 | 48 | 320.000 | 946.08 |
| 5 | 105.000 | 417.62 | 27 | 215.000 | 514.19 | 49 | 325.000 | 987.40 |
| 6 | 110.000 | 419.48 | 28 | 220.000 | 523.19 | 50 | 330.000 | 1031.76 |
| 7 | 115.000 | 421.47 | 29 | 225.000 | 533.00 | 51 | 335.000 | 1079.43 |
| 8 | 120.000 | 423.61 | 30 | 230.000 | 543.54 | 52 | 340.000 | 1130.61 |
| 9 | 125.000 | 425.92 | 31 | 235.000 | 554.88 | 53 | 345.000 | 1185.36 |
| 10 | 130.000 | 428.39 | 32 | 240.000 | 567.05 | 54 | 350.000 | 1244.47 |
| 11 | 135.000 | 430.97 | 33 | 245.000 | 580.03 | 55 | 355.000 | 1307.71 |
| 12 | 140.000 | 433.83 | 34 | 250.000 | 594.11 | 56 | 360.000 | 1375.48 |
| 13 | 145.000 | 436.91 | 35 | 255.000 | 609.24 | 57 | 365.000 | 1448.41 |
| 14 | 150.000 | 440.22 | 36 | 260.000 | 625.37 | 58 | 370.000 | 1526.44 |
| 15 | 155.000 | 443.77 | 37 | 265.000 | 642.87 | 59 | 375.000 | 1610.00 |
| 16 | 160.000 | 447.60 | 38 | 270.000 | 661.65 | 60 | 380.000 | 1699.54 |
| 17 | 165.000 | 451.71 | 39 | 275.000 | 681.73 | 61 | 385.000 | 1795.59 |
| 18 | 170.000 | 456.13 | 40 | 280.000 | 703.43 | 62 | 390.000 | 1898.32 |
| 19 | 175.000 | 460.89 | 41 | 285.000 | 726.63 | 63 | 395.000 | 2008.14 |
| 20 | 180.000 | 466.00 | 42 | 290.000 | 751.72 | 64 | 400.000 | 2125.64 |
| 21 | 185.000 | 471.49 | 43 | 295.000 | 778.54 | 65 | 405.000 | 2251.09 |
| 22 | 190.000 | 477.29 | 44 | 300.000 | 807.30 | 66 | 410.000 | 2384.93 |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 2 ( 20 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 367.47 | 18 | 170.000 | 412.06 | 35 | 255.000 | 573.57 |
| 2 | 90.000 | 368.75 | 19 | 175.000 | 416.98 | 36 | 260.000 | 590.94 |
| 3 | 95.000 | 370.16 | 20 | 180.000 | 422.26 | 37 | 265.000 | 609.63 |
| 4 | 100.000 | 371.66 | 21 | 185.000 | 427.98 | 38 | 270.000 | 629.59 |
| 5 | 105.000 | 373.32 | 22 | 190.000 | 434.04 | 39 | 275.000 | 651.26 |
| 6 | 110.000 | 375.10 | 23 | 195.000 | 440.68 | 40 | 280.000 | 674.36 |
| 7 | 115.000 | 376.98 | 24 | 200.000 | 447.81 | 41 | 285.000 | 699.42 |
| 8 | 120.000 | 379.06 | 25 | 205.000 | 455.52 | 42 | 290.000 | 726.18 |
| 9 | 125.000 | 381.34 | 26 | 210.000 | 463.81 | 43 | 295.000 | 755.14 |
| 10 | 130.000 | 383.79 | 27 | 215.000 | 472.76 | 44 | 300.000 | 786.17 |
| 11 | 135.000 | 386.46 | 28 | 220.000 | 482.27 | 45 | 305.000 | 819.49 |
| 12 | 140.000 | 389.32 | 29 | 225.000 | 492.64 | 46 | 310.000 | 855.30 |
| 13 | 145.000 | 392.43 | 30 | 230.000 | 503.80 | 47 | 315.000 | 894.02 |
| 14 | 150.000 | 395.77 | 31 | 235.000 | 515.83 | 48 | 320.000 | 935.49 |
| 15 | 155.000 | 399.40 | 32 | 240.000 | 528.63 | 49 | 325.000 | 980.08 |
| 16 | 160.000 | 403.30 | 33 | 245.000 | 542.58 | 50 | 330.000 | 1027.95 |
| 17 | 165.000 | 407.52 | 34 | 250.000 | 557.56 | 51 | 335.000 | 1079.41 |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 3 ( 40 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 32.000 EFF. YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 322.40 | 18 | 170.000 | 367.07 | 35 | 255.000 | 538.20 |
| 2 | 90.000 | 323.58 | 19 | 175.000 | 372.17 | 36 | 260.000 | 556.77 |
| 3 | 95.000 | 324.90 | 20 | 180.000 | 377.59 | 37 | 265.000 | 576.68 |
| 4 | 100.000 | 326.33 | 21 | 185.000 | 383.56 | 38 | 270.000 | 594.24 |
| 5 | 105.000 | 327.92 | 22 | 190.000 | 389.98 | 39 | 275.000 | 621.34 |
| 6 | 110.000 | 329.63 | 23 | 195.000 | 396.94 | 40 | 280.000 | 646.35 |
| 7 | 115.000 | 331.53 | 24 | 200.000 | 404.44 | 41 | 285.000 | 673.13 |
| 8 | 120.000 | 333.58 | 25 | 205.000 | 412.56 | 42 | 290.000 | 702.11 |
| 9 | 125.000 | 335.84 | 26 | 210.000 | 421.30 | 43 | 295.000 | 733.18 |
| 10 | 130.000 | 338.27 | 27 | 215.000 | 430.67 | 44 | 300.000 | 766.55 |
| 11 | 135.000 | 340.94 | 28 | 220.000 | 440.85 | 45 | 305.000 | 802.68 |
| 12 | 140.000 | 343.77 | 29 | 225.000 | 451.86 | 46 | 310.000 | 841.40 |
| 13 | 145.000 | 346.92 | 30 | 230.000 | 463.70 | 47 | 315.000 | 883.09 |
| 14 | 150.000 | 350.32 | 31 | 235.000 | 476.40 | 48 | 320.000 | 927.87 |
| 15 | 155.000 | 354.03 | 32 | 240.000 | 490.17 | 49 | 325.000 | 976.05 |
| 16 | 160.000 | 358.03 | 33 | 245.000 | 505.05 | 50 | 330.000 | 1027.83 |
| 17 | 165.000 | 362.38 | 34 | 250.000 | 521.03 | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 4 ( 60 DEG-F / HR COOLDOWN )

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = ADWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 276.14 | 18 | 170.000 | 321.09 | 34 | 250.000 | 484.51 |
| 2 | 90.000 | 277.22 | 19 | 175.000 | 326.40 | 35 | 255.000 | 503.04 |
| 3 | 95.000 | 278.45 | 20 | 180.000 | 332.14 | 36 | 260.000 | 522.85 |
| 4 | 100.000 | 279.80 | 21 | 185.000 | 338.39 | 37 | 265.000 | 544.39 |
| 5 | 105.000 | 281.32 | 22 | 190.000 | 345.07 | 38 | 270.000 | 567.56 |
| 6 | 110.000 | 282.98 | 23 | 195.000 | 352.41 | 39 | 275.000 | 592.47 |
| 7 | 115.000 | 284.84 | 24 | 200.000 | 360.31 | 40 | 280.000 | 619.25 |
| 8 | 120.000 | 286.86 | 25 | 205.000 | 368.90 | 41 | 285.000 | 648.32 |
| 9 | 125.000 | 289.10 | 26 | 210.000 | 378.08 | 42 | 290.000 | 679.42 |
| 10 | 130.000 | 291.33 | 27 | 215.000 | 388.12 | 43 | 295.000 | 712.96 |
| 11 | 135.000 | 294.23 | 28 | 220.000 | 398.93 | 44 | 300.000 | 749.23 |
| 12 | 140.000 | 297.14 | 29 | 225.000 | 410.65 | 45 | 305.000 | 788.19 |
| 13 | 145.000 | 300.35 | 30 | 230.000 | 423.27 | 46 | 310.000 | 830.05 |
| 14 | 150.000 | 303.78 | 31 | 235.000 | 436.85 | 47 | 315.000 | 875.16 |
| 15 | 155.000 | 307.59 | 32 | 240.000 | 451.56 | 48 | 320.000 | 923.67 |
| 16 | 160.000 | 311.71 | 33 | 245.000 | 467.48 | 49 | 325.000 | 975.90 |
| 17 | 165.000 | 316.22 | | | | | | |

CWE-COM COOLDOWN CURVES REG. GUIDE 1.99,REV.2 WITH MARGIN 05/15/92

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 5 ( 100 DEG-F/HR COOLDOWN )

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = AOWIN 1

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 179.66 | 17 | 165.000 | 220.68 | 33 | 245.000 | 393.00 |
| 2 | 90.000 | 180.56 | 18 | 170.000 | 226.01 | 34 | 250.000 | 412.88 |
| 3 | 95.000 | 181.64 | 19 | 175.000 | 231.88 | 35 | 255.000 | 434.33 |
| 4 | 100.000 | 182.84 | 20 | 180.000 | 238.25 | 36 | 260.000 | 457.54 |
| 5 | 105.000 | 184.24 | 21 | 185.000 | 245.22 | 37 | 265.000 | 482.55 |
| 6 | 110.000 | 185.81 | 22 | 190.000 | 252.77 | 38 | 270.000 | 509.62 |
| 7 | 115.000 | 187.61 | 23 | 195.000 | 260.99 | 39 | 275.000 | 538.76 |
| 8 | 120.000 | 189.60 | 24 | 200.000 | 269.92 | 40 | 280.000 | 570.15 |
| 9 | 125.000 | 191.85 | 25 | 205.000 | 279.65 | 41 | 285.000 | 604.21 |
| 10 | 130.000 | 194.33 | 26 | 210.000 | 290.18 | 42 | 290.000 | 640.73 |
| 11 | 135.000 | 197.11 | 27 | 215.000 | 301.59 | 43 | 295.000 | 680.14 |
| 12 | 140.000 | 200.15 | 28 | 220.000 | 313.96 | 44 | 300.000 | 722.57 |
| 13 | 145.000 | 203.54 | 29 | 225.000 | 327.41 | 45 | 305.000 | 768.33 |
| 14 | 150.000 | 207.23 | 30 | 230.000 | 341.93 | 46 | 310.000 | 817.58 |
| 15 | 155.000 | 211.33 | 31 | 235.000 | 357.63 | 47 | 315.000 | 870.66 |
| 16 | 160.000 | 215.78 | 32 | 240.000 | 374.64 | 48 | 320.000 | 927.73 |