WESTINGHOUSE PROPRIETARY CLASS 3

Methodology For Calculating Enable Temperature Set Point For Zion Units 1 & 2

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For Zion Units 1 & 2

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1. INTRODUCTION

The purpose of this report is to describe the methodology for calculating the enable temperature set point (ET) that defines a temperature range, ($T_{initial} \leq T \leq ET$), for which the low temperature overpressure protection system (LTOPS) must be operable during plant startup and shutdown conditions. The basis for determining the enable temperature is described first, followed by the basis for determining the Appendix G controlling location[4] (i.e., 1/4T or 3/4T) in the reactor vessel beltline during plant heatup and cooldown events. An example is then provided showing the method for calculating the enable temperature set point for Zion Unit 1.

2. BASIS FOR DETERMINING ENABLE TEMPERATURE

The enable temperature set point, as defined in the Standard Review Plan, Branch Technical Position RSB 5-2, "Overpressurization Protection of Pressurized Water Reactors While Operating at Low Temperatures"[2], is the water temperature corresponding to a metal temperature of at least $RT_{NDT} + 90°F$ at the beltline location (1/4T or 3/4T) that is controlling in the 10 CFR Part 50 Appendix G[3] fracture toughness limit calculations. Its purpose is to set a temperature range for which the low temperature overpressure protection system (LTOPS) should be operable during plant startup and shutdown conditions in order to assure the Appendix G limits for the reactor coolant system are not exceeded while operating at low temperatures. The temperature range, for which LTOPS should be operable, is defined to be all temperature values below the enable temperature.

The calculation of the enable temperature, using the definition described above, requires that the metal temperature difference (ΔT) between the reactor vessel bulk fluid and the controlling location be added to the value $RT_{NDT} + 90°F$, when the metal temperature at the controlling location reaches a temperature value of $RT_{NDT} + 90°F$. The metal temperature difference must be added in order to have the water temperature correspond to the controlling location metal temperature. Furthermore, the effect that the metal temperature difference has on enable temperature calculations is different for the reactor vessel heatup and cooldown processes.

During a plant cooldown, the controlling location is always at the 1/4T position and has a higher temperature value than the fluid adjacent to the vessel inner diameter. It follows that the ΔT ($T_{fluid} - T_{metal}$) metal temperature induced during cooldown is negative and results in a lower or less conservative enable temperature set point when included in the equation $ET = RT_{NDT} + 90°F + \Delta T$.

During a plant heatup, the controlling location switches between the 1/4T and 3/4T positions. However, these vessel locations are at a lower temperature than the fluid adjacent to the vessel inner diameter. It follows that the ΔT ($T_{fluid} - T_{metal}$) metal temperature difference induced during heatup are positive and result in a higher or more

conservative enable temperature set point when included in the equation $ET = RT_{NDT} + 90°F + \Delta T$.

From the above descriptions, and taking into account that the 1/4T RT_{NDT} value is greater than the 3/4T RT_{NDT} value, the maximum required enable temperature can be calculated during heatup when the largest ΔT metal temperature value at the 1/4T controlling location is added to the value $RT_{NDT} + 90°F$. However, if a large enough heatup rate is used, the maximum enable temperature can be calculated at the 3/4T controlling location due to the large ΔT metal temperature values at the 3/4T location. As a result, when the difference between the ΔT metal temperature values is greater than the difference between the RT_{NDT} values at the 1/4T and 3/4T locations, the maximum required enable temperature is calculated at the 3/4T controlling location. If the RT_{NDT} and ΔT differences between the 1/4T and 3/4T locations are the same, then the calculated enable temperature for both locations will be the same. Furthermore, when the enable temperature is calculated at the 3/4T controlling location, one must also verify that the value obtained bounds (i.e., be greater than) the enable temperature for all possible cooldown rates at the 1/4T location.

3. BASIS FOR DETERMINING CONTROLLING LOCATION

The method for determining the reactor vessel controlling location (1/4T or 3/4T) during plant heatups and cooldowns is described below in accordance with the rules outlined in ASME Code, Section III, Appendix G[4] and the fracture toughness requirements as defined in Appendix G of 10 CFR Part 50[3]. The methods used are, in detail, documented in WCAP-7924-A[5].

Heatup

In a heatup analysis, two distinct situations are analyzed. First, allowable pressure-temperature relationships are developed for steady-state (i.e., zero rate of change of temperature) conditions as well as finite heatup rate conditions, assuming a 1/4T deep flaw at the inner diameter of the reactor vessel. During a heatup of the reactor vessel, the thermal gradients in the vessel wall tend to produce compressive stresses at the 1/4T location, and as a result, the tensile stresses induced by internal pressure are somewhat alleviated. Therefore a pressure-temperature heatup curve based on steady-state conditions (i.e., no thermal stresses) represents a lower bound of all similar curves for finite heatup rates when the 1/4T flaw is considered. However, during heatup, especially at the end of the heatup transient, conditions may exist so that the effects of compressive thermal stresses and tensile pressure stresses 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 1/4T flaw is considered. Therefore, both cases (i.e., steady-state and finite heatup) have to be

analyzed in order to ensure that the lower value of the allowable pressure calculated for steady-state and finite heatup rates is obtained.

Secondly, allowable pressure-temperature relationships are developed for a finite heatup rate, assuming a 1/4T-deep flaw at the outer diameter of the reactor vessel (i.e., the 3/4T location). Unlike the situation at the inner diameter, at the outer diameter position the thermal gradients established during heatup produce stresses which are tensile in nature and thus tend to reinforce the pressure stresses present. These thermal stresses are dependent on both the rate of heatup and the time along the heatup ramp. Furthermore, since the thermal stresses at the outer diameter are tensile and increase with increasing heatup rate, a lower bound curve similar to that described above cannot be defined. Rather, each heatup rate of interest must be analyzed on an individual basis.

Following the generation of pressure-temperature relationships for both the steady-state and finite heatup rate situations, a composite heatup curve of pressure-temperature values is constructed 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 values taken from the heatup curves under consideration (i.e., steady-state, 1/4T and 3/4T finite heatup). The locations under consideration having the lowest pressure for a given temperature determines the reactor vessel controlling location.

During the generation of the heatup composite curve, the outer diameter (3/4T position) is initially the controlling location. However, the possibility exists for the controlling location to switch from the 3/4T to the 1/4T position during the reactor vessel heat up process. In addition, the reactor vessel fluid temperature in which the switch over occurs also changes as the effective full power years (EFPY) of the vessel change, therefore, the switch over temperature is not a fixed value but changes with RT_{NDT}.

Cooldown

The cooldown analysis proceeds in the same fashion as that for heatup, with the exception that the controlling location is always at the inner diameter. The thermal gradients induced during cooldown tend to produce tensile stresses at the inner diameter location (1/4T) and compressive stresses at the outer diameter location (3/4T). Thus, the inner diameter flaw is clearly the worst case, and as a result, the 1/4T position is always the controlling location for a reactor vessel cooldown process.

4. CALCULATION OF ENABLE TEMPERATURE FOR 32 EFPY

Results from WCAP-13406, "Heatup and Cooldown Limit Curves for Normal Operation For Zion Units 1 & 2"[1], are used to calculate an enable temperature set point for 32 EFPY with instrumentation error margins, assuming a heatup rate of 60 °F per hour. The variations of the metal temperature difference (ΔT) between the reactor vessel bulk fluid and the 1/4T and 3/4T controlling locations for a 60 °F per hour heatup rate are provided in Figures 1 and 2. Figure 1, entitled "Metal Temperature Difference (°F) vs. Reactor Vessel Fluid Temperature (°F)", shows the metal temperature difference for the 1/4T and 3/4T positions corresponding to a fluid temperature adjacent to the reactor vessel inner diameter. Similarly, Figure 2, entitled "Metal Temperature Difference (°F) vs. Time (Hours)", shows the metal temperature differences as a function of time throughout the reactor vessel heatup process. Figure 2 is provided for information purposes only and is not required to calculate the enable temperature set point. Table 1 contains the data points used to generate the curves in Figures 1 and 2 and will be used to calculate the metal temperature difference (ΔT) in the enable temperature calculation process.

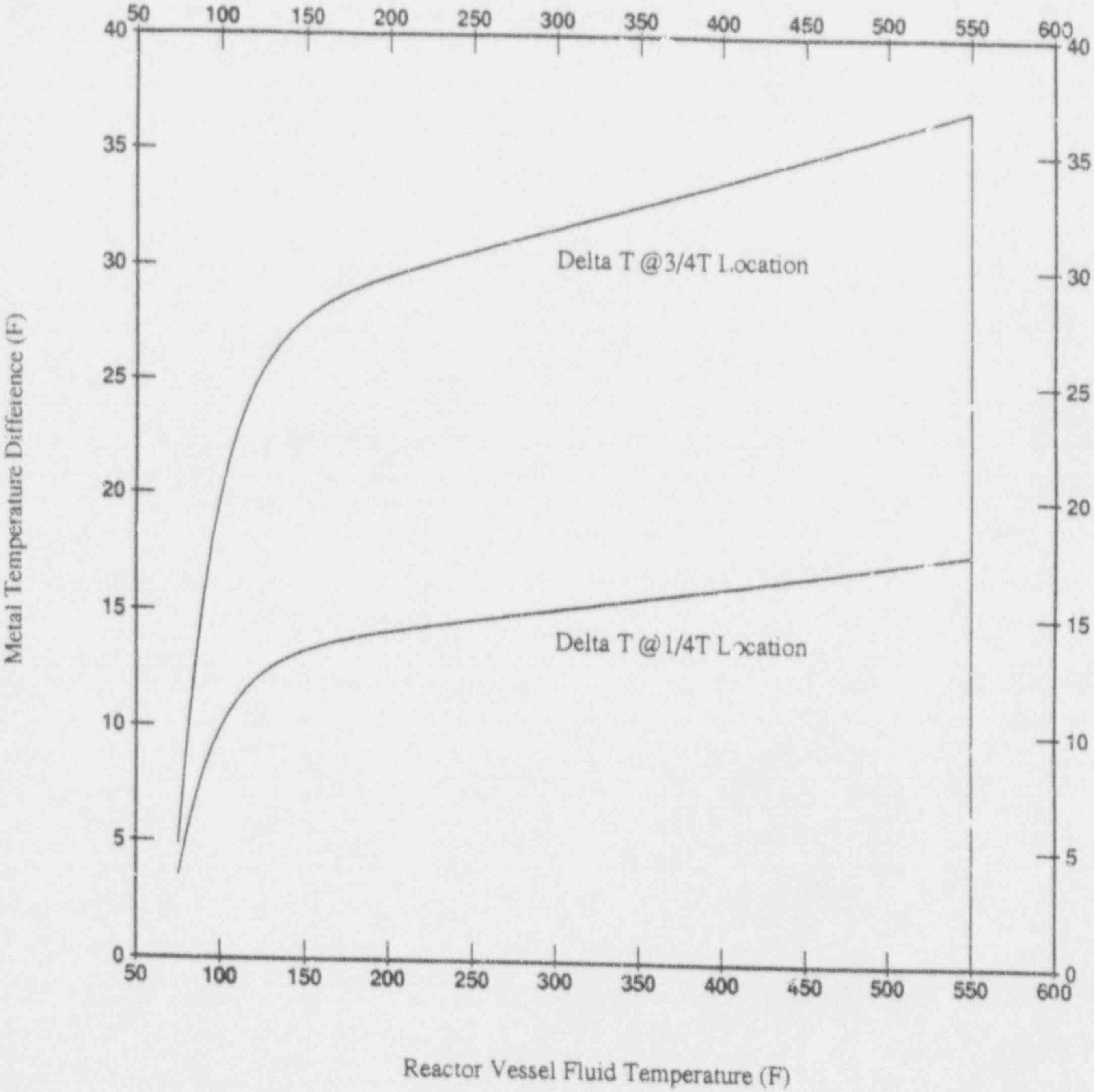


Figure 1

Variation of Metal Temp. Difference with Reactor Vessel Fluid Temp.
For Zion Units 1 & 2 Using a 60 Deg. F per Hour Heatup Rate

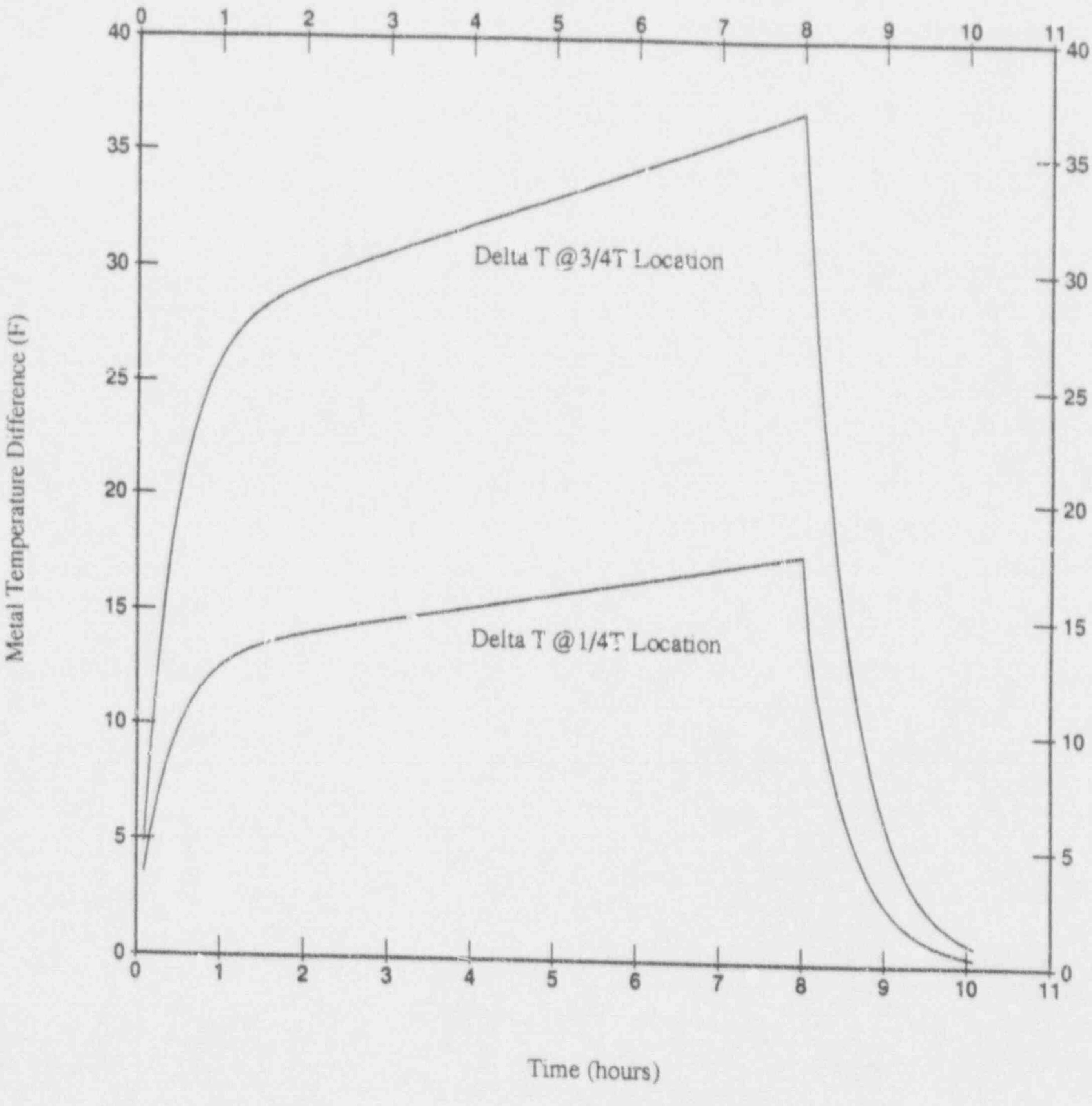


Figure 2

Variation of Metal Temp. Difference with Time
For Zion Units 1 & 2 Using a 60 Deg. F per Hour Heatup Rate

Table 1: Zion Units 1 & 2 Temperature Variations For 60 °F per Hour Heatup Rate

Time (sec.)	Time (hours)	Water Temp. (°F)	1/4T Temp. (°F)	3/4T Temp. (°F)	ΔT @ 1/4T (°F)	ΔT @ 3/4T (°F)
300	0.083	75	71	70	4	5
600	0.167	80	75	71	5	9
900	0.250	85	78	72	7	13
1200	0.333	90	82	74	8	16
1500	0.417	95	86	77	9	18
1800	0.500	100	90	80	10	20
2100	0.583	105	94	84	11	21
2400	0.667	110	99	87	11	23
2700	0.750	115	103	91	12	24
3000	0.833	120	108	95	12	25
3300	0.917	125	113	100	12	25
3600	1.000	130	117	104	13	26
3900	1.083	135	122	108	13	27
4200	1.167	140	127	113	13	27
4500	1.250	145	132	118	13	27
4800	1.333	150	137	122	13	28
5100	1.417	155	142	127	13	28
5400	1.500	160	146	132	14	28
5700	1.583	165	151	137	14	28
6000	1.667	170	156	141	14	29
6300	1.750	175	161	146	14	29
6600	1.833	180	166	151	14	29
6900	1.917	185	171	156	14	29
7200	2.000	190	176	161	14	29
7500	2.083	195	181	166	14	29

Table 1: Zion Units 1 & 2 Temperature Variations For 60 °F per Hour Heatup Rate (Cont.)

Time (sec.)	Time (hours)	Water Temp. (°F)	1/4T Temp. (°F)	3/4T Temp. (°F)	ΔT @ 1/4T (°F)	ΔT @ 3/4T (°F)
7800	2.167	200	186	170	14	30
8100	2.250	205	191	175	14	30
8400	2.333	210	196	180	14	30
8700	2.417	215	201	185	14	30
9000	2.500	220	206	190	14	30
9300	2.583	225	211	195	14	30
9600	2.667	230	216	200	14	30
9900	2.750	235	220	205	15	30
10200	2.833	240	225	210	15	30
10500	2.917	245	230	214	15	31
10800	3.000	250	235	219	15	31
11100	3.083	255	240	224	15	31
11400	3.167	260	245	229	15	31
11700	3.250	265	250	234	15	31
12000	3.333	270	255	239	15	31
12300	3.417	275	260	244	15	31
12600	3.500	280	265	249	15	31
12900	3.583	285	270	254	15	31
13200	3.667	290	275	259	15	31
13500	3.750	295	280	263	15	32
13800	3.833	300	285	268	15	32
14100	3.917	305	290	273	15	32
14400	4.000	310	295	278	15	32
14700	4.083	315	300	283	15	32
15000	4.167	320	305	288	15	32
15300	4.250	325	310	293	15	32

Table 1: Zion Units 1 & 2 Temperature Variations For 60 °F per Hour Heatup Rate (Cont.)

Time (sec.)	Time (hours)	Water Temp. (°F)	1/4T Temp. (°F)	3/4T Temp. (°F)	ΔT @ 1/4T (°F)	ΔT @ 3/4T (°F)
15600	4.333	330	315	298	15	32
15900	4.417	335	320	303	15	32
16200	4.500	340	324	308	16	32
16500	4.583	345	329	312	16	33
16800	4.667	350	334	317	16	33
17100	4.750	355	339	322	16	33
17400	4.833	360	344	327	16	33
17700	4.917	365	349	332	16	33
18000	5.000	370	354	337	16	33
18300	5.083	375	359	342	16	33
18600	5.167	380	364	347	16	33
18900	5.250	385	369	352	16	33
19200	5.333	390	374	357	16	33
19500	5.417	395	379	361	16	34
19800	5.500	400	384	366	16	34
20100	5.583	405	389	371	16	34
20400	5.667	410	394	376	16	34
20700	5.750	415	399	381	16	34
21000	5.833	420	404	386	16	34
21300	5.917	425	409	391	16	34
21600	6.000	430	414	396	16	34
21900	6.083	435	419	401	16	34
22200	6.167	440	423	405	17	35
22500	6.250	445	428	410	17	35
22800	6.333	450	433	415	17	35
23100	6.417	455	438	420	17	35

Table 1: Zion Units 1 & 2 Temperature Variations For 60 °F per Hour Heatup Rate (Cont.)

Time (sec.)	Time (hours)	Water Temp. (°F)	1/4T Temp. (°F)	3/4T Temp. (°F)	ΔT @ 1/4T (°F)	ΔT @ 3/4T (°F)
23400	6.500	460	443	425	17	35
23700	6.583	465	448	430	17	35
24000	6.667	470	453	435	17	35
24300	6.750	475	458	440	17	35
24600	6.833	480	463	445	17	35
24900	6.917	485	468	[illegible]	17	35
25200	7.000	490	473	454	17	36
25500	7.083	495	478	459	17	36
[illegible]	7.167	500	483	464	17	36
[illegible]	7.250	505	488	469	17	36
[illegible]	7.333	510	493	474	17	36
26700	7.417	515	498	479	17	36
27000	7.500	520	503	484	17	36
27300	7.583	525	508	489	17	36
27600	7.667	530	513	494	17	36
27900	7.750	535	517	498	18	37
28200	7.833	540	522	503	18	37
28500	7.917	545	527	508	18	37
28800	8.000	550	532	513	18	37
29100	8.083	550	536	518	14	32
29400	8.167	550	538	522	12	28
29700	8.250	550	540	526	10	24
30000	8.333	550	541	530	9	20
30300	[illegible]	550	543	533	7	17
[illegible]	[illegible]	550	544	535	6	15
30900	8.583	550	544	537	6	13

Table 1: Zion Units 1 & 2 Temperature Variations For 60 °F per Hour Heatup Rate (Cont.)

Time (sec.)	Time (hours)	Water Temp. (°F)	1/4T Temp. (°F)	3/4T Temp. (°F)	ΔT @1/4T (°F)	ΔT @3/4T (°F)
31200	8.667	550	545	539	5	11
31500	8.750	550	546	540	4	10
31800	8.833	550	547	542	3	8
32100	8.917	550	547	543	3	7
32400	9.000	550	547	544	3	6
32700	9.083	550	548	545	2	5
33000	9.167	550	548	546	2	4
33300	9.250	550	548	546	2	4
33600	9.333	550	549	547	1	3
33900	9.417	550	549	547	1	3
34200	9.500	550	549	548	1	2
34500	9.583	550	549	548	1	2
34800	9.667	550	549	548	1	2
35100	9.750	550	549	548	1	2
35400	9.833	550	549	549	1	1
35700	9.917	550	550	549	0	1
36000	10.000	550	550	549	0	1
36300	10.083	550	550	549	0	1

In order to determine which Appendix G controlling location is controlling for a given reactor vessel fluid temperature during a heatup process, the following table was constructed. Table 2 provides the Zion Unit 1 controlling locations for a given reactor vessel fluid temperature for 14, 20, 25, and 32 EFPY using 20, 40, 60, and 100 °F per hour heatup rates. The temperature ranges in Table 2 reflect which controlling location has the limiting allowable pressure during the reactor vessel heatup process. Note, this table can be generated with or without instrumentation error margins without effecting the end result of the enable temperature set point calculation.

Table 2: Zion Unit 1 Temperature Ranges for Appendix G Controlling Locations (With Instrumentation Error Margins)

EFPY	Finite Heatup Rate (°F/Hr)	Temp. Range For 3/4T Controlling Loc. (°F)	Temp. Range For 1/4T Controlling Loc. Under Steady-State Conditions (°F) *	Temp. Range For 1/4T Controlling Loc. (°F)
14	20	95 ≤ T ≤ 115	120 ≤ T ≤ 300	305 ≤ T ≤ 550
	40	90 ≤ T ≤ 200	205 ≤ T ≤ 305	310 ≤ T ≤ 550
	60	90 ≤ T ≤ 275	280 ≤ T ≤ 305	310 ≤ T ≤ 550
	100	95 ≤ T ≤ 385	-	390 ≤ T ≤ 550
20	20	90 ≤ T ≤ 130	135 ≤ T ≤ 315	320 ≤ T ≤ 550
	40	90 ≤ T ≤ 210	215 ≤ T ≤ 320	325 ≤ T ≤ 550
	60	90 ≤ T ≤ 280	285 ≤ T ≤ 320	325 ≤ T ≤ 550
	100	90 ≤ T ≤ 390	-	395 ≤ T ≤ 550
25	20	90 ≤ T ≤ 135	140 ≤ T ≤ 325	330 ≤ T ≤ 550
	40	90 ≤ T ≤ 215	220 ≤ T ≤ 330	335 ≤ T ≤ 550
	60	90 ≤ T ≤ 290	295 ≤ T ≤ 330	335 ≤ T ≤ 550
	100	90 ≤ T ≤ 400	-	405 ≤ T ≤ 550
32	20	90 ≤ T ≤ 145	150 ≤ T ≤ 335	340 ≤ T ≤ 550
	40	90 ≤ T ≤ 225	230 ≤ T ≤ 340	345 ≤ T ≤ 550
	60	90 ≤ T ≤ 295	300 ≤ T ≤ 340	345 ≤ T ≤ 550
	100	90 ≤ T ≤ 410	-	415 ≤ T ≤ 550

* For this temp. range, the steady-state condition provided the limiting allowable pressure in the Appendix G calculations.

The OPERLIM computer code[6] was used to calculate the temperature values induced in the reactor vessel beltline for the 60 °F per hour heatup process. The calculation procedures used by OPERLIM comply with the rules outlined in ASME Code, Section III, Appendix G[4] as required by the criteria of Appendix G to 10CFR Part 50[3].

Using Tables 1 and 2, the enable temperature calculations for 32 EFPY using a 60 °F per hour heatup rate are as follows:

- o the RT_{NDT} values for the limiting beltline region are 242.88 °F and 194.10 °F for the 1/4T and 3/4T locations, respectively.
- o From Table 2, the Appendix G controlling location temperature ranges are (90 °F $\leq T \leq$ 295 °F) for the 3/4T position, (300 °F $\leq T \leq$ 340 °F) for the 1/4T position under steady-state conditions, and (345 °F $\leq T \leq$ 550 °F) for the 1/4T position.

For the temperature range (90 °F $\leq T \leq$ 295 °F), the 3/4T position controls, therefore,

$$ET = RT_{NDT} + 90°F + \Delta T$$

$$ET = 194.10\ °F + 90\ °F + 32\ °F = 316.10\ °F$$

where, ΔT = 32 °F represents the metal temperature difference $(T_{fluid} - T_{(3/4)T})$ when the 3/4T controlling location reaches a temperature value of 284 °F (i.e., $RT_{NDT} + 90°F$).

For the temperature range (300 °F $\leq T \leq$ 340 °F), the 1/4T position controls under steady-state conditions, therefore,

$$ET = RT_{NDT} + 90°F$$

$$ET = 242.88\ °F + 90\ °F = 332.88\ °F$$

Note, the metal temperature difference, ΔT, is excluded due to steady-state conditions.

For the temperature range (345 °F $\leq T \leq$ 550 °F), the 1/4T position controls, therefore,

$$ET = RT_{NDT} + 90°F + \Delta T$$

$$ET = 242.88\ °F + 90\ °F + 16\ °F = 348.88\ °F$$

where, ΔT = 16 °F represents the metal temperature difference $(T_{fluid} - T_{(1/4)T})$ when the 1/4T controlling location reaches a temperature value of 333 °F (i.e., $RT_{NDT} + 90°F$).

Taking into account the cooldown rates used in WCAP-13406 for 32 EFPY (20, 40, 60, and 100 °F per hour), the ET calculations are as follows.

For Cooldown, $ET = RT_{NDT} + 90°F + \Delta T$ at the 1/4T position.

Using 20 °F/Hr cooldown rate:

$ET = 242.88\ °F + 90\ °F - 5\ °F = 327.88\ °F$

where, $\Delta T = -5\ °F$ represents the metal temperature difference $(T_{fluid} - T_{(1/4)T})$ when the 1/4T controlling location reaches a temperature value of 333 °F.

Using 40 °F/Hr cooldown rate:

$ET = 242.88\ °F + 90\ °F - 11\ °F = 321.88\ °F$

where, $\Delta T = -11\ °F$ represents the metal temperature difference $(T_{fluid} - T_{(1/4)T})$ when the 1/4T controlling location reaches a temperature value of 333 °F.

Using 60 °F/Hr cooldown rate:

$ET = 242.88\ °F + 90\ °F - 16\ °F = 316.88\ °F$

where, $\Delta T = -16\ °F$ represents the metal temperature difference $(T_{fluid} - T_{(1/4)T})$ when the 1/4T controlling location reaches a temperature value of 333 °F.

Using 100 °F/Hr cooldown rate:

$ET = 242.88\ °F + 90\ °F - 27\ °F = 305.88\ °F$

where, $\Delta T = -27\ °F$ represents the metal temperature difference $(T_{fluid} - T_{(1/4)T})$ when the 1/4T controlling location reaches a temperature value of 333 °F.

The results of this example show that the bounding enable temperature set point occurs at the 1/4T controlling location for 32 EFPY using a 60 °F per hour heatup rate. The value calculated, 348.88 °F, supports up to 32 EFPY and heatup rates between 0 °F and 60 °F per hour. In addition, this value defines the temperature range, (70 °F < T < 348.88 °F), in

which the LTOPS system must be turned on during reactor vessel heatup and cooldown events to ensure safe operating conditions at low temperatures.

In conclusion, the enable temperature set point must be calculated for the largest possible plant heatup rate using the equation, $ET = RT_{NDT} + 90°F + \Delta T$. This will ensure the LTOPS system operates within the required temperature range which prevents the reactor vessel from exceeding pressure-temperature limitations at low temperatures.

Appendix A contains a range of $RT_{NDT} + 90°F$ values at the 1/4T location for a given EFPY for Zion Units 1 & 2. These values can be used along with metal temperature differences provided in Table 1 to calculate the enable temperature set point.

5. REFERENCES

1. WCAP-13406, "Heatup and Cooldown Limit Curves for Normal Operation For Zion Units 1 & 2", M. A. Ramirez, et al., July 1992.
2. NUREG-0800, "Overpressurization Protection of Pressurized Water Reactors While Operating at Low Temperatures", Branch Technical Position RSB 5-2, Chapter 5.2.2 in Standard Review Plan, Revision 1, November 1988.
3. Code of Federal Regulations, 10 CFR Part 50, Appendix G, "Fracture Toughness Requirements", U.S. Nuclear Regulatory Commission, Washington, D.C., Federal Register, Vol. 48 No. 104, May 27, 1983.
4. Appendix G to the ASME Boiler & Pressure Vessel Code, Section III, "Protection Against Nonductile Failure", American Society of Mechanical Engineers, New York, 1989 Edition.
5. WCAP-7924-A, "Basis For Heatup And Cooldown Limit Curves", W. S. Hazelton, et al, April 1975.
6. WCAP-9186, "Documentation And Verification Of The OPERLIM Computer Code", O. Meeuwis, et al, August 1977.

APPENDIX A

Data Points and Graphs

RT_{NDT} vs EFPY for 1/4T Location

Table A1: RT_{NDT} @1/4T vs EFPY For Zion Units 1 & 2

	Zion Unit 1 Circ. Weld WF-70		Zion Unit 2 Circ. Weld SA-1769	
EFPY (Years)	RTNDT @ 1/4T (°F)	RTNDT @ 1/4T + 90 (°F)	RTNDT @ 1/4T (°F)	RTNDT @ 1/4T + 90 (°F)
10	193	283	184	274
12	200	290	192	282
14	206	296	199	289
16	212	302	205	295
18	217	307	211	301
20	222	312	216	306
22	226	316	221	311
24	230	320	225	315
25	232	322	227	317
26	233	323	229	319
28	237	327	233	323
30	240	330	237	327
32	243	333	240	330
34	246	336	243	333
36	248	338	246	336
38	251	341	249	339
40	253	343	251	341
42	255	345	254	344
44	257	347	256	346
46	259	349	259	349
48	261	351	261	351

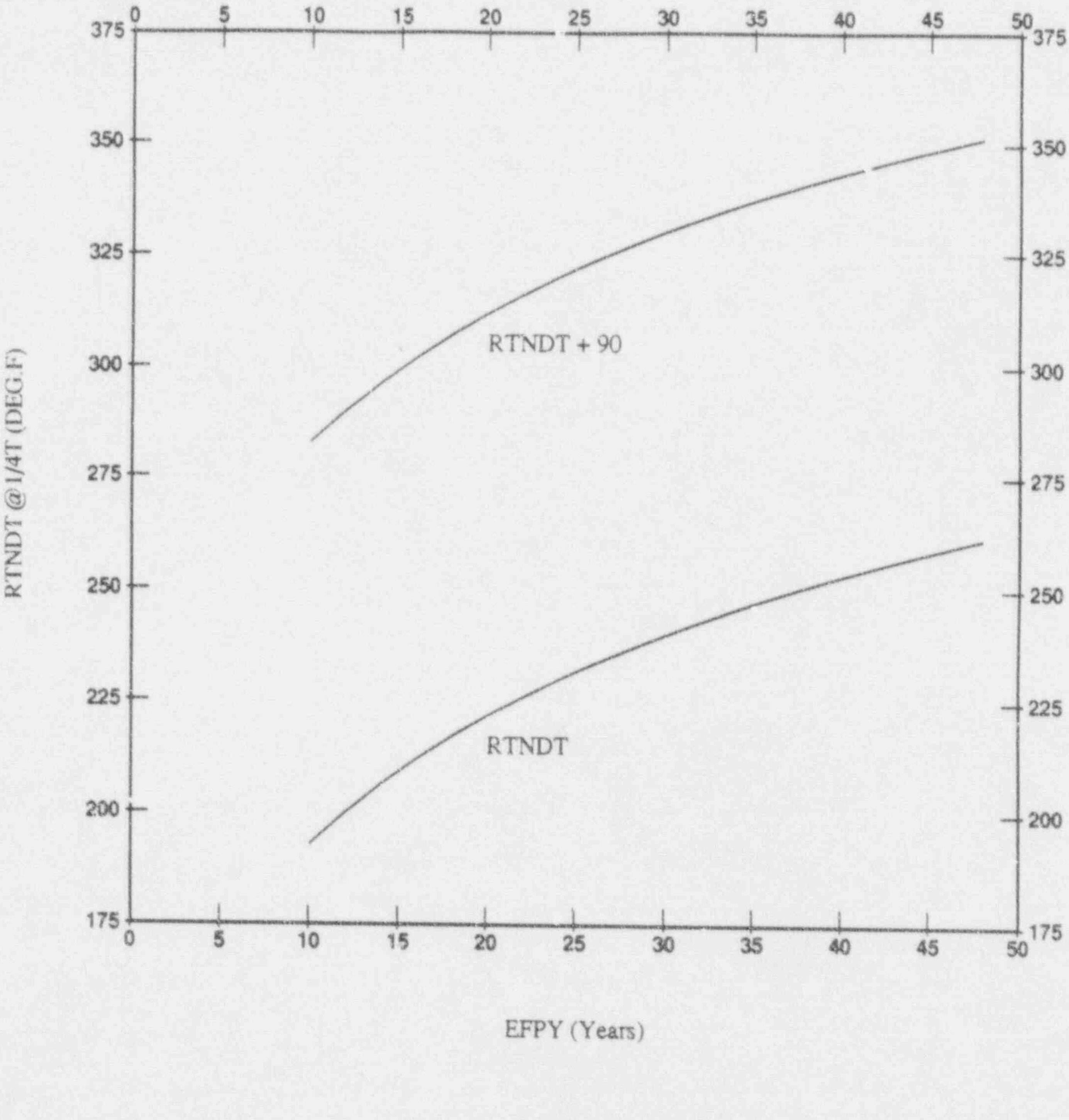


Figure A1

RTNDT @ 1/4T vs EFPY For Zion Unit 1

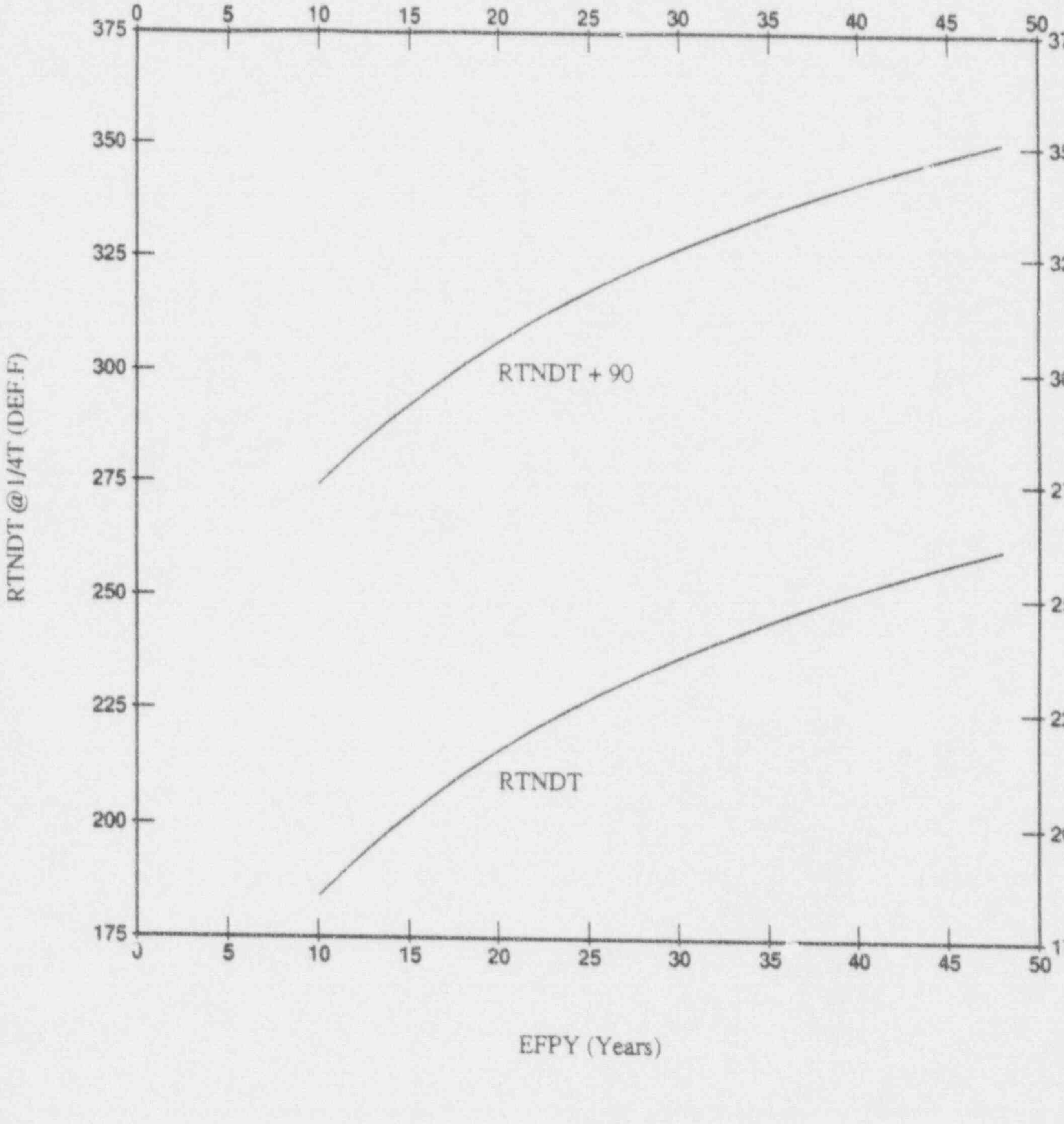


Figure A2

RTNDT @ 1/4T vs EFPY For Zion Unit 2

ENCLOSURE 6

PRESSURE AND TEMPERATURE LIMITS REPORT

COMMONWEALTH EDISON COMPANY

ZION UNITS 1 & 2

PRESSURE AND TEMPERATURE LIMITS REPORT

REVISION 0

1.0 Pressure and Temperature Limits

This Pressure and Temperature Limits Report for Zion Units 1 and 2 has been prepared in accordance with the requirements of Technical Specification Section 6.6.1.G. The pressure and temperature limits have been developed using the methodology described in the reference.

The following pressure and temperature limits are included in this report:

1) Allowable Heatup and Cooldown Rates

2) Reactor Coolant System Heatup Limitations Curves

3) Reactor Coolant System Cooldown Limitations Curves

4) Inservice Leak and Hydrostatic Test Limitations

2.0 Reference

1. Westinghouse Electric Corporation, Topical Report WCAP-13406, "Heatup and Cooldown Limit Curves for Normal Operation for Zion Units 1 & 2", July 1992.

ALLOWABLE HEATUP AND COOLDOWN RATES

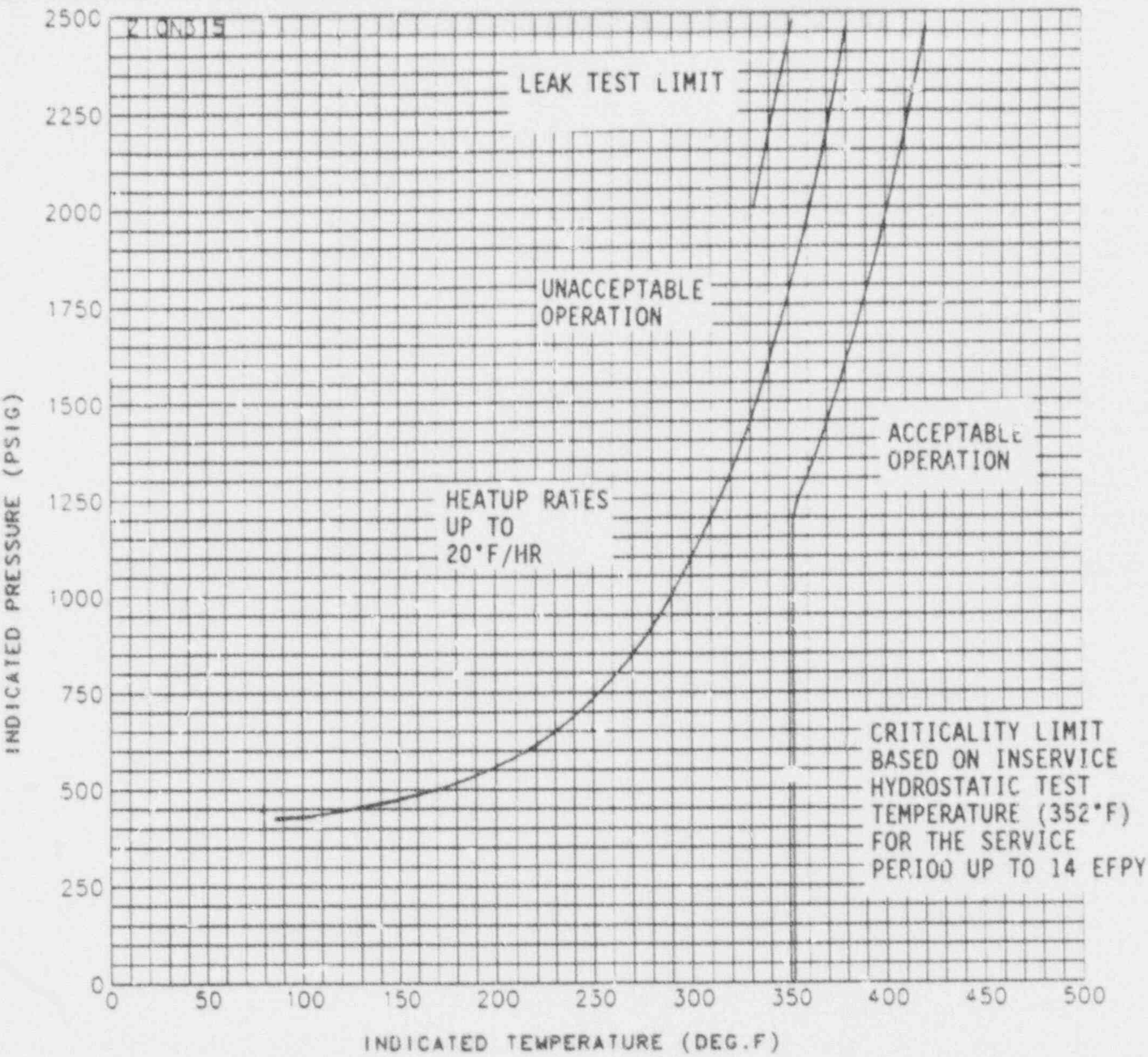
> **NOTE**
>
> These limits are referred to by Technical Specification 3.3.2.A.

a. A maximum heatup rate of 20°F/hr applicable up to and including 180°F RCS indicated temperature. A maximum heatup rate of 60°F/hr applicable for RCS indicated temperatures greater than 180°F.

b. A maximum cooldown of 100°F in any 1 hour period.

c. A maximum temperature change of $\leq$ 10°F in any 1 hour period during inservice hydrostatic and leak testing operations above the heatup and cooldown limit curves.

REACTOR COOLANT SYSTEM HEATUP LIMITATIONS

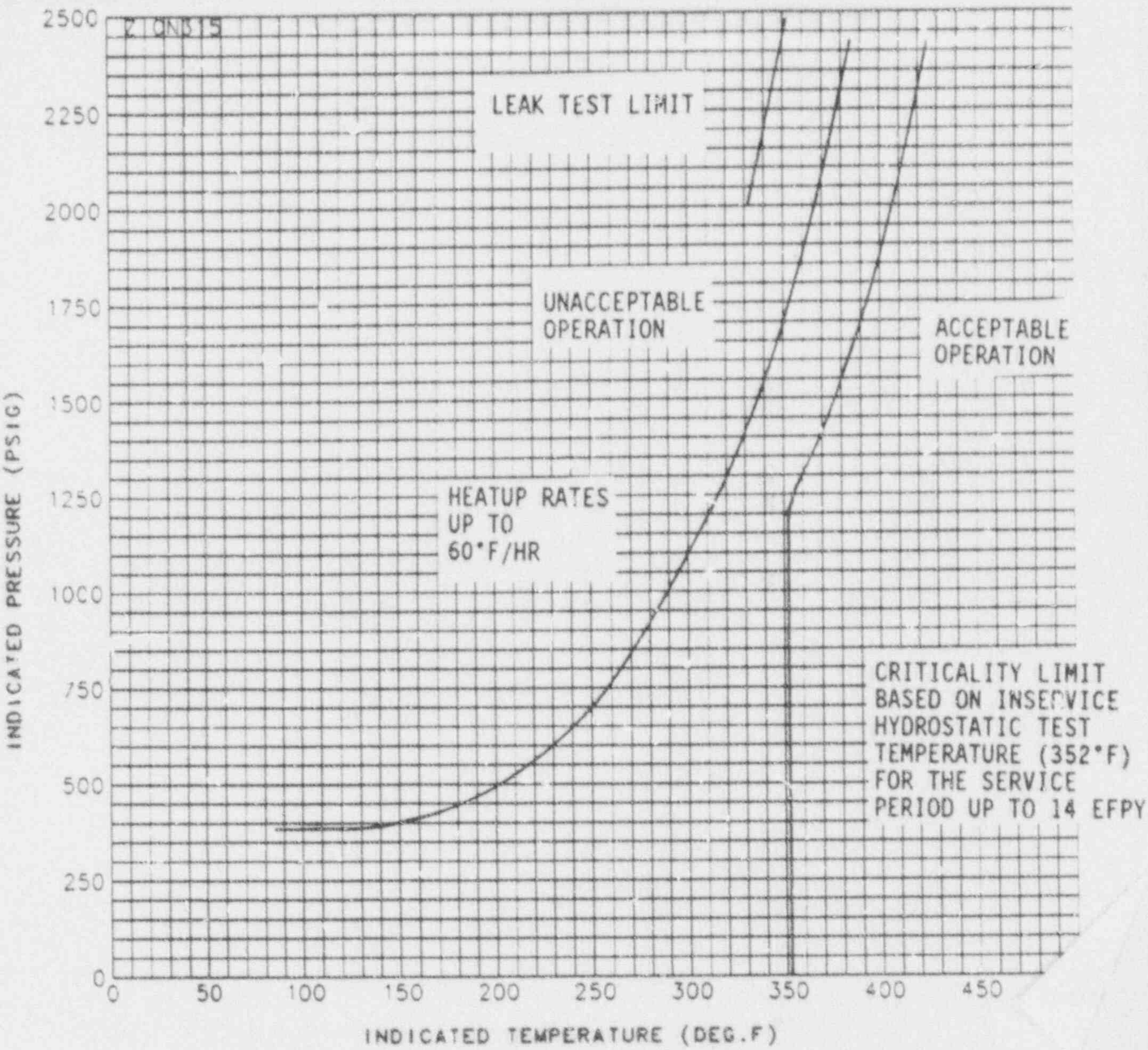


NOTE

These curves are referred to by Technical Specification 3.3 2.A.

Applicable to Zion Units 1 and 2 for up to 14 EFPY and heatup rates up to 20°F/hr. Curves contain margins of 10°F and 60 psig for instrumentation errors.

REACTOR COOLANT SYSTEM HEATUP LIMITATIONS

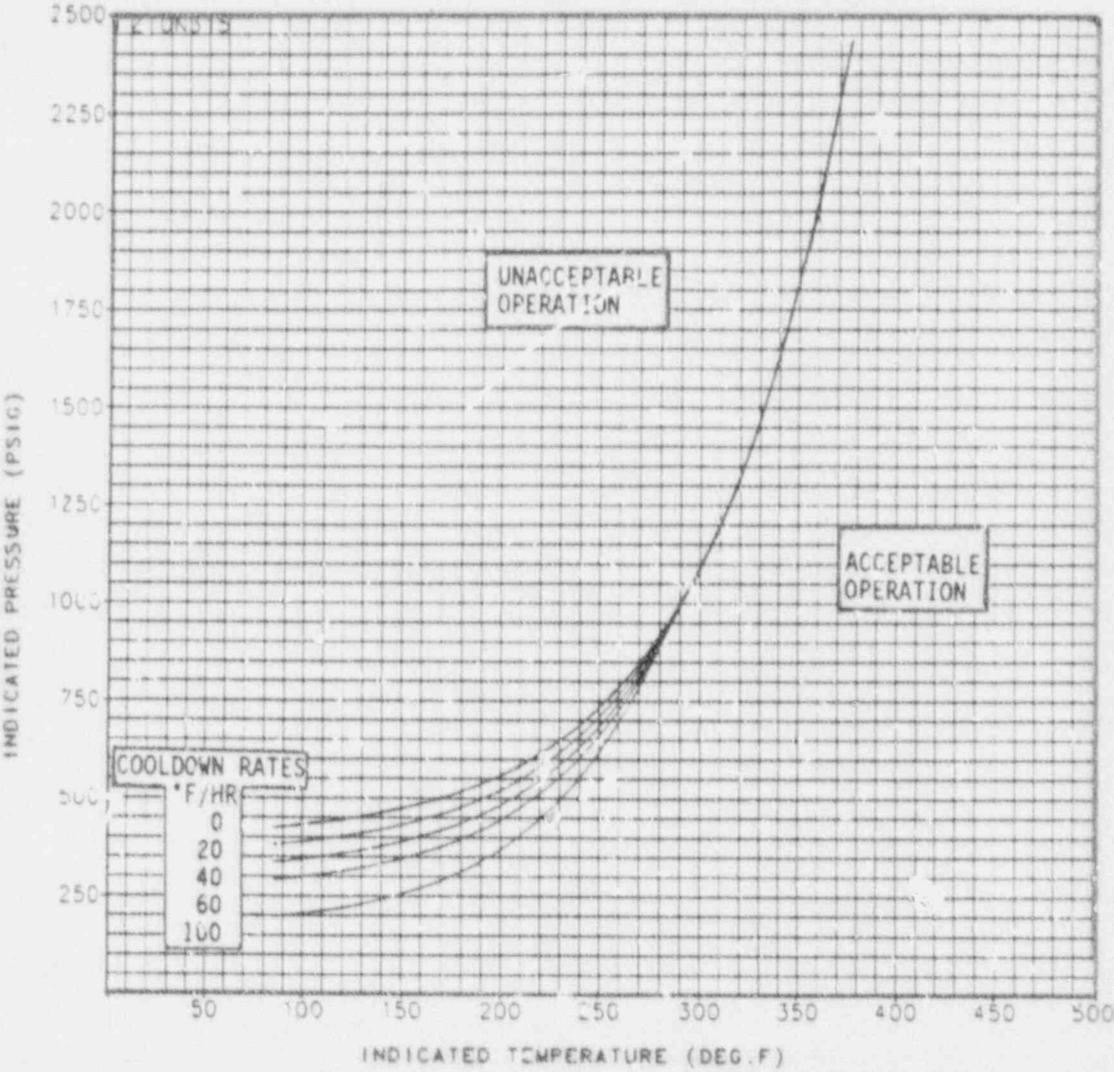


NOTE

These curves are referred to by Technical Specification 3 3.2.A.

Applicable to Zion Units 1 and 2 for up to 14 EFPY and heatup rates up to 60°F/hr. Curves contain margins of 10°F and 60 psig for instrumentation errors.

REACTOR COOLANT SYSTEM COOLDOWN LIMITATIONS



NOTE

These curves are refe..ed to by Technical Specification 3.3.2.A.

Applicable to Zion Units 1 and 2 for up to 14 EFPY and cooldown rates up to 100°F/hr. Curves contain margins of 10°F and 60 psig for instrumentation errors.