3.1.3 COMBINED HEATUP, COOLDOWN AND PRESSURE LIMITATIONS

Applicability: Applies to heatup and cooldown of the reactor coolant system.

Objective: To maintain the structural integrity of the reactor coolant system throughout the lifetime of the plant.

Specification:

A. Reactor pressure and heatup and cooldown of the reactor coolant system during the first 16 years of equivalent full power operation shall be limited in accordance with Figures 3.1.3a and 3.1.3b. Thereafter, limits shall be based on neutron exposure equivalent to not less than 16 years of full power operation, and Figures 3.1.3a and 3.1.3b shall be updated accordingly.

B. Figures 3.1.3a and 3.1.3b shall be updated in accordance with the following criteria and procedures:

(1) The methods of Appendix G, "Protection Against Nonductile Failure", to Section III of the ASME Boiler and Pressure Vessel Code shall be used to obtain the allowable pressure-temperature relationships for the reactor coolant system.

(2) The curves in Figure 3.1.3c shall be used in predicting the reference nil-ductility temperature increase, ΔRT_{NDT}, unless measurements on the irradiation specimens show ΔRT_{NDT}s greater than those predicted by the curves, in which case a new curve having the same slope as the original shall be constructed.

C. The pressurizer heatup rate of 100^oF/hour and cooldown rate of 195^oF/hour shall not be exceeded.

D. The reactor shall not be brought to a critical condition until the pressure-temperature state is to the right of the criticality limit line as shown in Figures 3.1.3a.

Basis: The initial Reference Nil Ductility Temperature (RT_{NDT}) for all reactor vessel material based on Charpy V-notch data, drop weight tests, and conservative estimates* is 82^oF or less. The RT_{NDT} at the 1/4 thickness location (location of Appendix G reference flaw tip) increases as a function of cumulative neutron exposure up to approximately 240^oF for the core region of the reactor vessel after 30 years of operation.

* NRC Standard Review Plan Branch Technical Position MTEB 5-2.

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A sixteen (16) equivalent full power year service period was chosen for the operational limits given in this specification because at the end of this period the limiting RT_{NDT} of the reactor vessel at the 1/4 thickness location is approximately 217°F in the core region. This RT_{NDT} is at least 50°F above the RT_{NDT} of all other regions in the primary reactor coolant system.

The highest RT_{NDT} of the core region material is determined by adding the radiation induced ΔRT_{NDT} for the applicable time period to the original RT_{NDT} shown in the Table 3.1.3.1. The fast neutron ($E \geq 1$Mev) fluence at 1/4 thickness and 3/4 thickness vessel locations is given as a function of full power service life in Figure 3.1.3d. Using the applicable fluence at the end of the year period and the copper content of the material in question, the ΔRT_{NDT} is obtained from Figure 3.1.3c.

Values of ΔRT_{NDT} may continue to be determined in this manner unless measurements on the irradiation specimens show ΔRT_{NDT}s greater than those predicted by the curves for the equivalent capsule exposure.

Allowable pressure-temperature relationships for various heatup and cooldown rates are calculated using methods derived from non-mandatory Appendix G in Section III of the ASME Boiler and Pressure Vessel Code, and discussed in detail in Reference 1.

The results of these calculations are provided in Reference 2.

The design heatup and cooldown rates for the pressurizer are 100°F/hour and 200°F/hour, respectively.

The straight line portion of the criticality limit given in Figures 3.1.3a is at the minimum permissable temperature for the 2485 psig in-service hydrostatic test as required by Appendix G to 10CFR Part 50. The curved portion of the criticality limit is shifted 40°F to the right of the heatup curve as required by Appendix G to 10CFR Part 50.

References:

(1) "Pressure Temperature Limits" Section 5.3.2 of Standard Review Plan, NUREG-751087, 1975.

(2) S. E. Yanichko, et al, "Analysis of Capsule F from the Southern California Edison Company San Onofre Reactor Vessel Radiation Surveillance Program", WCAP 9520, May 1979.

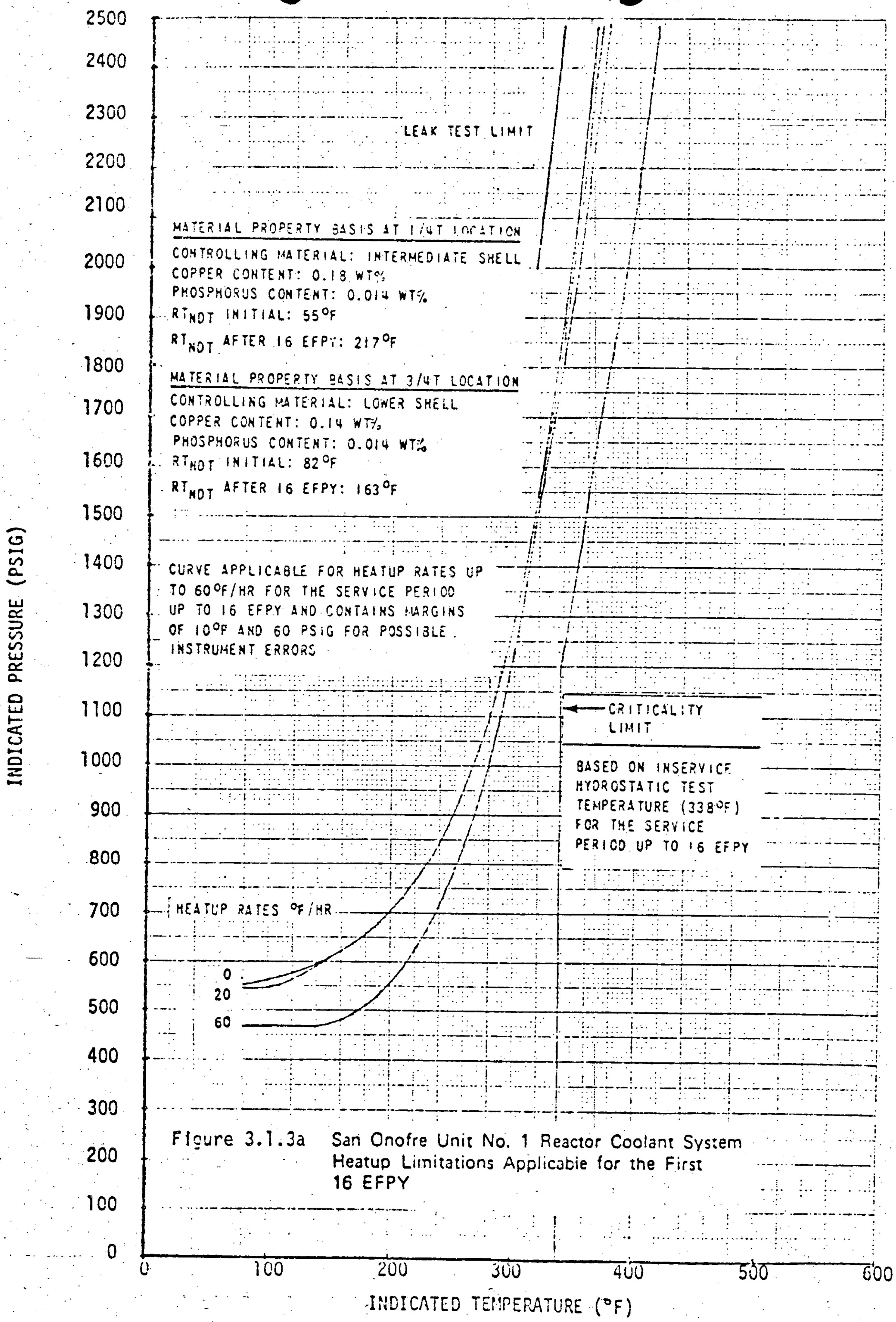

Figure 3.1.3a San Onofre Unit No. 1 Reactor Coolant System Heatup Limitations Applicable for the First 16 EFPY

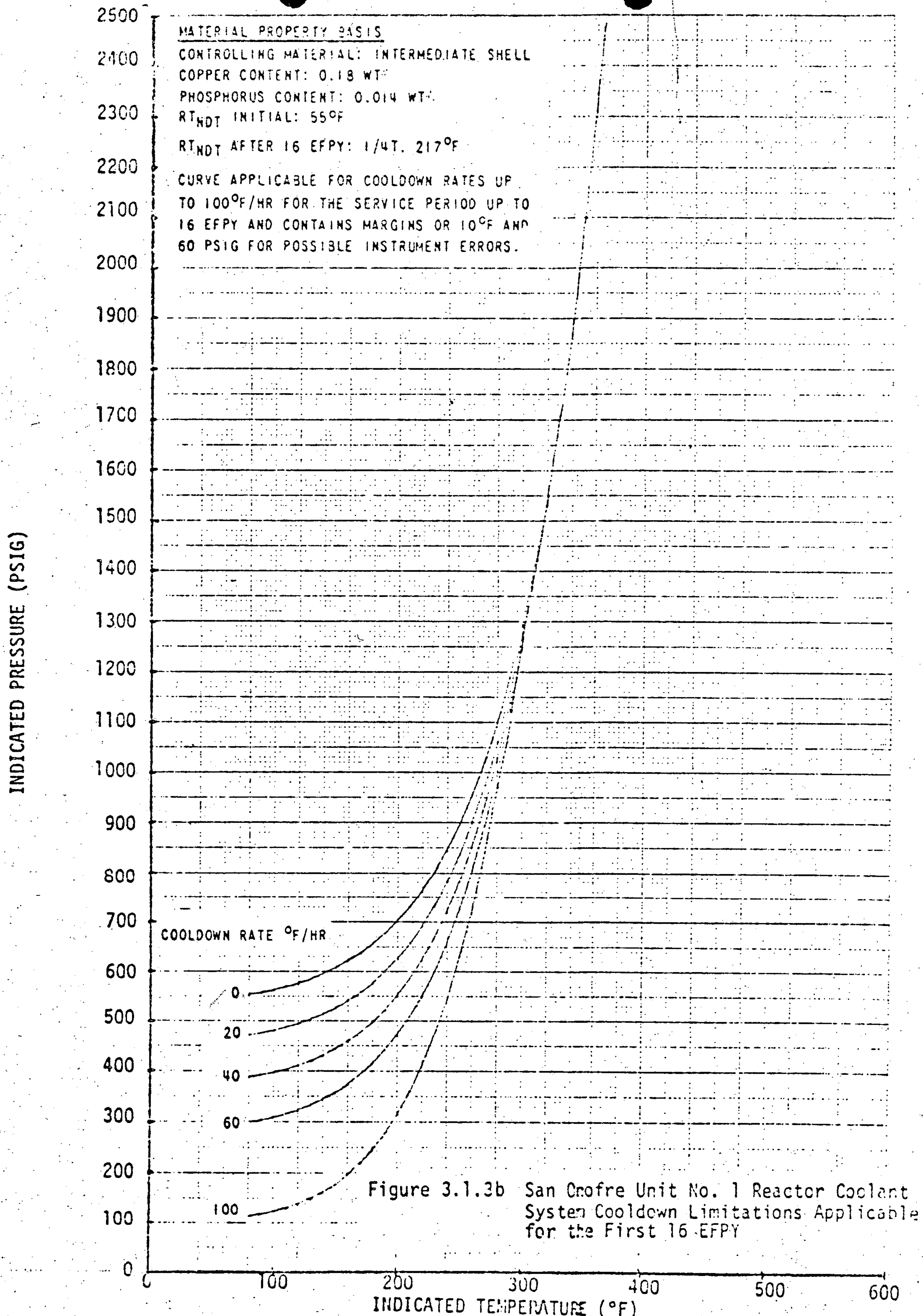

Figure 3.1.3b San Onofre Unit No. 1 Reactor Coolant System Cooldown Limitations Applicable for the First 16 EFPY

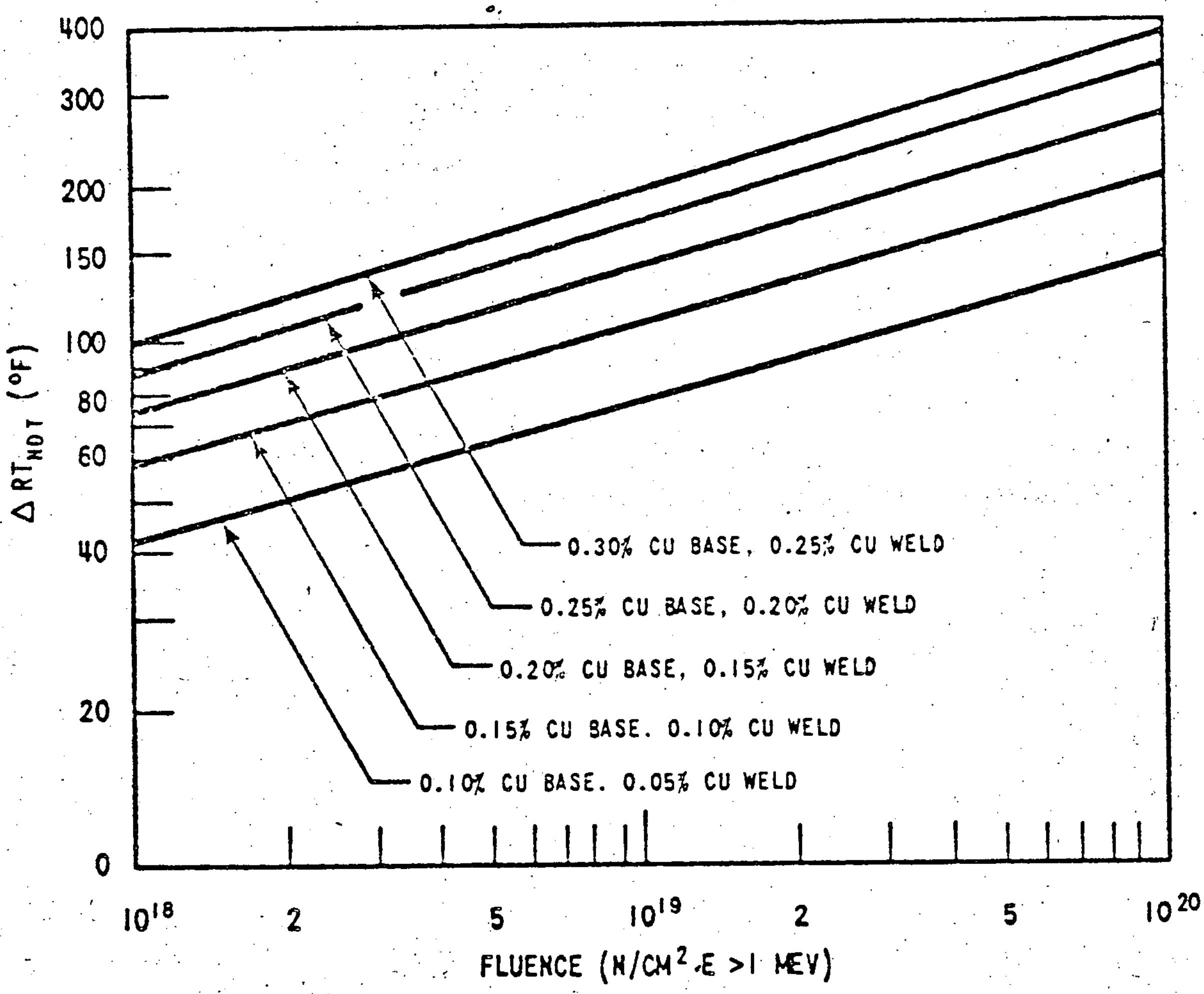

Figure 3.1.3c Effect of Fluence and Copper Content on ΔRT_{NDT} for Reactor Vessel Steels Exposed to Irradiation at 550°F

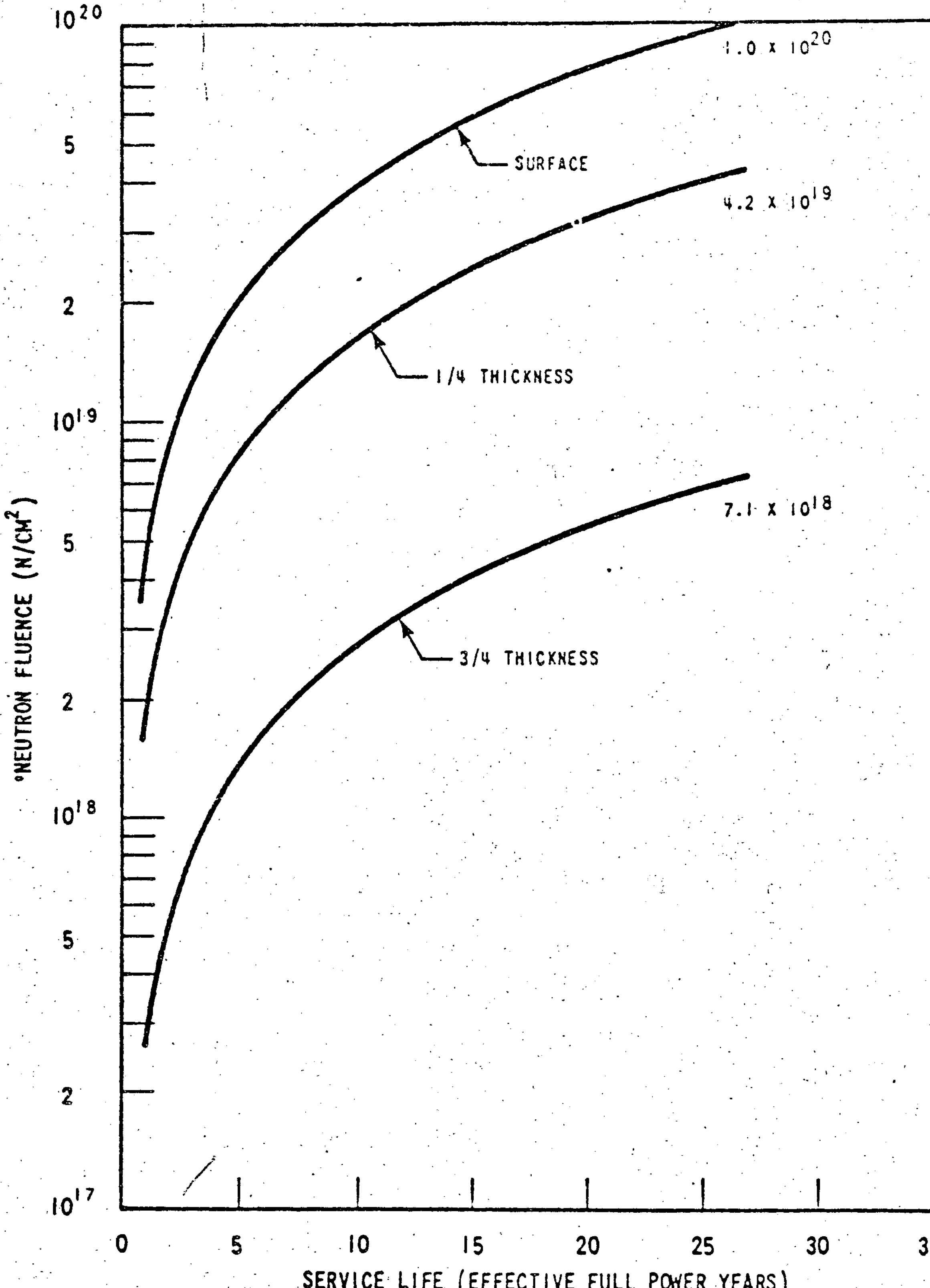

Figure 3.1.3d Fast Neutron Fluence (E > 1 Mev) as a Function of Full-Power Service Life

TABLE 3.1.3.1

REACTOR VESSEL TOUGHNESS DATA (UNIRRADIATED)

Component	Code No.	Material Type	Cu (%)	P (%)	NDTT (°F)	Minimum 50 ft-lb/35 mil Temp (°F)		RT_{NDT} (°F)	Average Upper Shelf Energy (ft-lb)	
						Long.	Trans.		Long.	Trans.
Cl. Hd. Dome	W7604	A302B	—	—	60[a]	112	132	72	72.5	—
Peel Segment	W7605-1	A302B	—	—	-10	114	134	74	70.5	—
Peel Segment	W7605-2	A302B	—	—	-10	90	110	50	122	—
Peel Segment	W7605-3	A302B	—	—	-10	108	128	68	85	—
Peel Segment	W7605-4	A302B	—	—	-10	120	140	80	74	—
Peel Segment	W7605-5	A302B	—	—	-10	26	46	-10	109	—
Peel Segment	W7605-6	A302B	—	—	-10	102	122	62	88	—
Hd. Flange	W7602	A336 mod	—	—	60[a]	[b]	—	60	—	—
Ves. Flange	W7603	A336 mod	—	—	60[a]	[b]	—	60	—	—
Inlet Nozzle	W7611-1	A336 mod	—	—	60[a]	[b]	—	60	—	—
Inlet Nozzle	W7611-2	A336 mod	—	—	60[a]	[b]	—	60	—	—
Inlet Nozzle	W7611-3	A336 mod	—	—	60[a]	[b]	—	60	—	—
Outlet Nozzle	W7610-1	A336 mod	—	—	60[a]	[b]	—	60	—	—
Outlet Nozzle	W7610-2	A336 mod	—	—	60[a]	[b]	—	60	—	—
Outlet Nozzle	W7610-3	A336 mod	—	—	60[a]	[b]	—	60	—	—
Upper Shell	W7601-3	A302B	0.15	0.014	-10	48	68	8	98.5	—
Upper Shell	W7601-6	A302B	0.16	0.012	-30	64	84	24	104	—
Upper Shell	W7601-7	A302B	0.15	0.014	-20	52	72	12	95.5	—

a. Estimated per NRC Standard Review Plan Branch Technical Position MTEB 5-2.

b. Only 10°F Charpy V-notch data available. Conservative estimates for NDTT and RT_{NDT} were used.

TABLE 3.1.3.1 (CONT.)

REACTOR VESSEL TOUGHNESS DATA (UNIRRADIATED)

Component	Code No.	Material Type	Cu (%)	P (%)	NDTT (°F)	Minimum 50 ft-lb/35 mil Temp (°F)		RT_{NDT} (°F)	Average Upper Shelf Energy (ft-lb)	
						Long.	Trans.		Long.	Trans.
Inter. Shell	W7601-1	A302B	0.17	0.013	0	57	120[a]	60	94	75
Inter. Shell	W7601-8	A302B	0.18	0.012	10	93	100[a]	40	97	79
Inter. Shell	W7601-9	A302B	0.18	0.014	0	64	115[a]	55	102	72
Lower Shell	W7601-2	A302B	0.17	0.013	-20	74	94	34	97	—
Lower Shell	W7601-4	A302B	0.14	0.014	-10	91	111	51	94	—
Lower Shell	W7601-5	A302B	0.14	0.014	10	122	142	82	87.5	—
Bot. Hd. Peel	W7607	A302B	—	—	-20	62	82	22	91	—
Bot. Hd. Dome	W7606	A302B	—	—	60[b]	99	119	60	86	—
Weld	—	—	0.19	0.017	0[b]	—	29[a]	0	—	90
HAZ	—	—	—	—	0[b]	—	-14[a]	0	—	101

a. Actual not estimated

b. Estimated per NRC Standard Review Plan Branch Technical Position MTEB 5-2.