CALCULATION TITLE PAGE

PROJECT SONGS 1 JOB ORDER NO. _____ DISCIPLINE NUCLEAR

SUBJECT: Overpressure Mitigating System Setpoint Evaluation

CALCULATION NO. DC-1562 NO. PAGES _____

RESPONSIBLE ENGINEER (signature) William G. Flannery DATE 2-9-84

INDEPENDENT REVIEW ENG. (signature) Howard S Smith DATE 2-9-84

ORIGINAL ISSUE

	NAME	DATE	SIGNATURE
GROUP LEADER	D.F. Pilmer	2/10/84	D.F. Pilmer
DISCIPLINE SUP. ENGR.			
OTHER			

RECORD OF REVISIONS

NO.	REASON FOR REVISION	DATE	RESP. ENGR.	IRE	GL	DSE	OTHER

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DESIGN INPUT SHEET

☑ Design Requirements
☐ Design Input Change

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DESIGN CALCULATION NO. DC — 1562

SUBJECT	PROJECT
Overpressure Mitigating System Setpoint Evaluation	San Onofre Unit 1

QUALITY CLASS	SEISMIC CLASS	SPECIFICATION REFERENCE
SR	A	

Design Input

Reference 1. described a low temperature overpressurization event that occurred at San Onofre Unit 1 on November 10, 1983 and recommended that the Overpressure Mitigating System (OMS) PORV setpoint be reviewed to determine if a setpoint adjustment was necessary.

The basis for the current PORV setpoint (522 psig) was reviewed in References 2 and 3. It was concluded that the November 10, 1983 event represented a more limiting low temperature overpressure case than that assumed in the original setpoint analysis and the setpoint was recalculated. The results of the calculation indicate that with a PORV setpoint value of $\boxed{500 \text{ psig}}$, the OMS will be capable of limiting all low temperature pressure transients below current Technical Specification limits.

RESPONSIBLE ENGINEER	DATE	INDEPENDENT REVIEW ENGINEER	DATE	GROUP LEADER	DATE
W.G. Flournoy	2-9-84	[signature]	2-9-84	D.F. Pilmer	2/10/8

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SUBJECT: OMS Setpoint Evaluation DWG. NO.

J.O. NO. MADE BY [illegible] DATE 2-9-84 CHK. BY [illegible] DATE 2-9-84

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1. PURPOSE

The purpose of this calculation is to determine a revised PORV setpoint for the OMS in consideration of the low temperature over-pressurization event that occurred at San Onofre Unit 1 on November 10, 1983 described in Reference 1.

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2. SUMMARY

A calculation of a revised PORV setpoint for the OMS was performed in consideration of the low temperature overpressurization event that occurred at San Onofre Unit 1 on November 10, 1983 described in Reference 1. The basis for the current PORV setpoint (522 psig) was reviewed in Reference 2 and it was concluded that the November 10, 1983 event represented a more limiting case which required PORV setpoint adjustment. Using the methodology of Reference 3 and input from Reference 4 a revised PORV setpoint of 500 psig was calculated. The calculation results indicate that with a PORV setpoint value of 500 psig, the OMS is capable of limiting low temperature overpressure transients to below limits specified in Reference 4.

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3. ASSUMPTIONS

1. The OMS design and plant specific parameters for setpoint determination are based on Reference 2. A revised mass input rate for the limiting case described subsequently in this calculation was determined from Reference 5.

2. The PORV setpoint is based on the results of the generic bounding transient analysis and guide for setpoint/overshoot determination in Reference 3.

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4. METHODOLOGY

Determination of relief valve setpoint requires knowledge of the expected pressure overshoot which could occur for all possible overpressure transients. In Reference 3 analyses were performed for bounding overpressure transients to generate values of setpoint overshoot. To determine a specific relief valve setpoint, a means of interpolating the setpoint overshoot from the generic envelope was provided and algorithms were developed to facilitate such interpolation. This methodology is extracted from Reference 3 and provided as Attachment A to this calculation.

The mass input algorithm involves the use of a procedure for the determination of relief valve setpoint which includes interpolation of setpoint overshoot for plants with RCS volume, relief valve setpoint, relief valve opening time, and mass input rate different from, but included within, the envelope of generic setpoint overshoot resul

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5. CALCULATION

Limiting Case

Two mass input cases were analyzed in Reference 3: inadvertent isolation of letdown while charging to a water solid system, and inadvertent safety injection. Administrative controls discussed in Reference 6 preclude inadvertent safety injection. Therefore, the limiting case selected in Reference 2 for setpoint determination was inadvertent isolation of letdown while charging to a water-solid RCS. The limiting mass input for this event was determined to be 110 gpm which represents the maximum charging flow from one charging pump under manual control during cooldown operations.

In the November 10, 1983 event described in Reference, an inadvertent SI actuation occurred with the RCS solid. The SI actuation resulted in the startup of the second charging pump and the charging line flow control valve FCV-1112 going wide open. This resulted in a mass input of greater than the 110 gpm which had been previously assumed

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Subsequent corrective action included implementing the provisions of Proposed Change No. 71 by TCN to Charging and Letdown System Procedure SO1-4-6 which restricts the maximum number of operable centrifugal charging pumps to one when the RCS pressure is less than or equal to 400 psig and the pressurizer water level is greater than 50%.

Reference 2 estimated the mass input from one charging pump with FCV-1112 wide open to be 179 gpm which exceeds the mass input assumed in the original setpoint determination.

Reference 5 indicates the flow from one charging pump with FCV-1112 wide open with the RCS depressurized could be as high as 320 gpm. Hence, it was conservatively assumed that a mass input rate of 320 gpm following an inadvertent SI event represents the limiting case. Administrative controls described in Reference 6 continue to preclude flow from SI/FW pumps during an inadvertent SI event.

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Plant Parameters

Other plant parameter inputs required for setpoint determination are listed below:

Relief Valve Capacity, C_v	31 gpm/$\sqrt{psi}$
Relief Valve Setpoint	500 psig (trial)
Relief Valve Opening Time	2.0 sec
RCS Volume	6752 ft^3

Reference Overshoot

Using the methodology of Attachment A, the reference overshoot ΔP_{REF} is obtained from Figure 4.2.1 for the limiting mass input rate. The reference overshoot curve must be adjusted for the SONGS1 relief valve capacity ($C_v = 31$) compared to the reference relief valve capacity ($C_v = 50$).

From Reference 2, Figure M2, determine the overshoot for 1 reference relief valve (80 psi) and 2 reference relief valves (46 psi), assuming no delay in valve opening time. Construct a log-log crossplot (Figure 1) of pressure overshoot vs. relief valve capacity and extrapolate to 62% of 1 reference relief valve to obtain the overshoot for the SONGS1 relief valve (117 psi).

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From Reference 2, Figure M26 determine the overshoot during the 0.6 second delay time before the valve starts to relieve (75 psi). Add the two overshoot components to obtain the total overshoot (192 psi). Construct plot of reference pressure overshoot ΔP_{REF} vs. mass input rate (dashed line on Figure 4.2.1) corresponding to 500GSI relief valve. From this plot, determine ΔP_{REF} for a mass input rate of 320 gpm (44 lb/sec):

$$\Delta P_{REF} = 75 \text{ psi}$$

<u>Setpoint Determination</u>

Use equation (1) and Figures 4.2.2, 4.2.3, and 4.2.4 of Attachment A to determine overshoot:

$$\Delta P(V, S, Z, X) = \Delta P_{REF} * F_V * F_S * F_Z$$

$$\Delta P = (75 \text{ psi})(.95)(.73)(1.14) = \boxed{60 \text{ psi}}$$

Determine peak RCS pressure:

$$P_{MAX} = \text{Setpoint} + \Delta P_{REF}$$

$$= 500 + 60$$

$$= \boxed{560 \text{ psi}}$$

The Technical Specification 3.1.3 limit at an RCS temperature of 100°F is $\boxed{565°F}$ (Tech Spec limit curves are provided as Attachment B). Hence, a revised PORV setpoint of $\boxed{500 \text{ psig}}$ meets Appendix G limits.

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6. REFERENCES

1. Letter J.G. Haynes to Harold B. Ray, subject Technical Specification Violation, San Onofre Nuclear Generating Station Unit 1, December, 1983.
2. Letter K.P. Baskin to A. Schwencer, subject Evaluation of Reactor Vessel Overpressurization Susceptibility, San Onofre Nuclear Generating Station Unit 1, dated October 12, 1977.
3. "Pressure Mitigating Systems Transient Analysis Results" Westinghouse Electric Corporation, dated July, 1977.
4. San Onofre Nuclear Generating Station Unit 1 Technical Specification 3.1.3 Combined Heatup, Cooldown, and Pressure Limitations
5. San Onofre Nuclear Generating Station Unit 1 Part II Final Safety Analysis, Volume 3, Section 4.1.6.
6. Letter K.P. Baskin to D.L. Ziemann, subject Reactor Vessel Overpressurization San Onofre Nuclear Generating Station Unit 1, dated March 7, 1978

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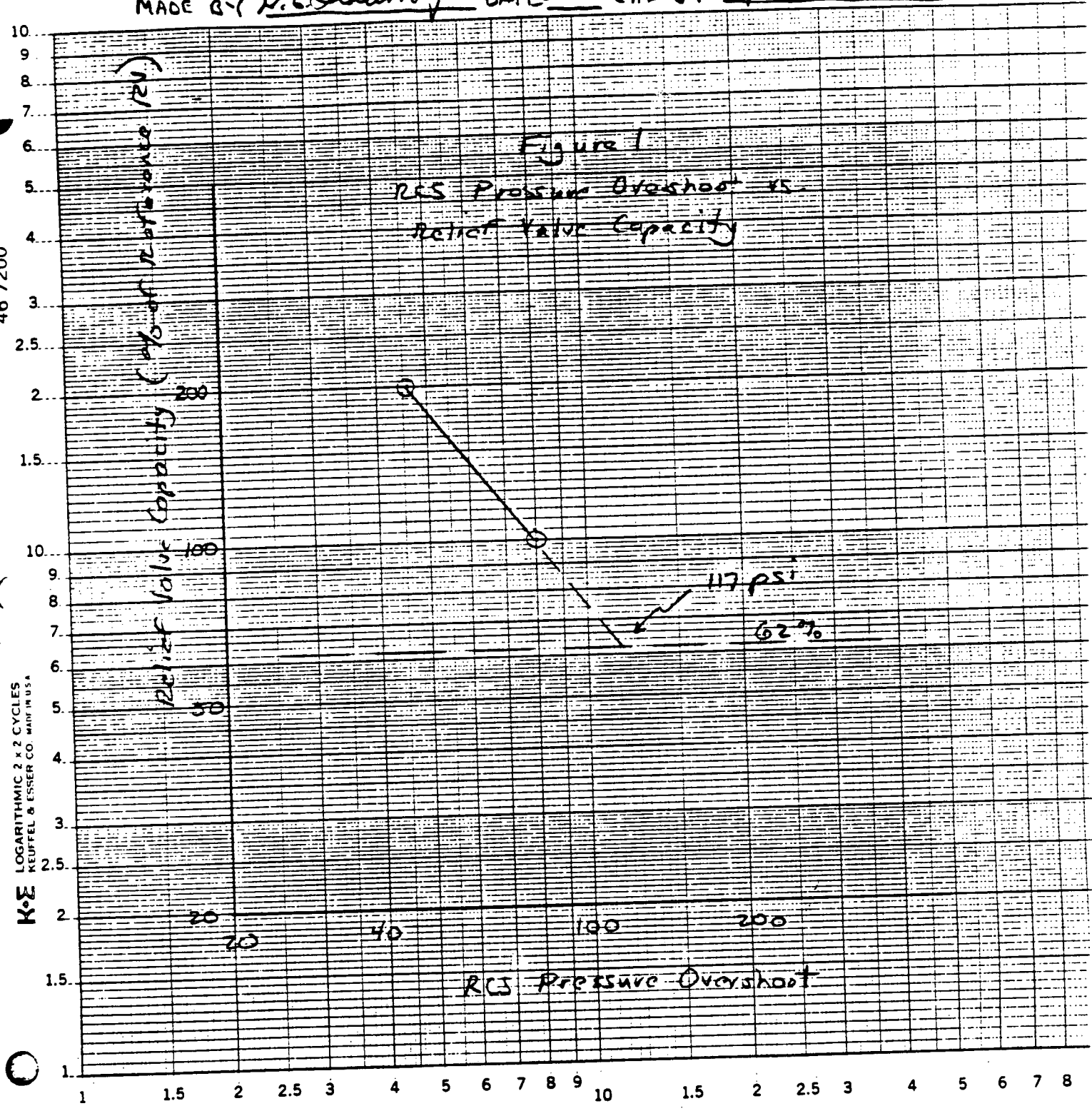

Figure 1
RCS Pressure Overshoot vs.
Relief Valve Capacity

4.2 ALGORITHMS USED FOR SETPOINT/OVERSHOOT DETERMINATION

4.2.1 Setpoint Determination for Mass Input Transient

Determination of a relief valve setpoint which will not result in a peak pressure in excess of the Appendix G limit, for the case of mass input as applied to a specific operating plant, is accomplished with a procedure based on the following simplified interpolating equation:

$$\Delta P\ (V,\ S,\ Z,\ x) = \Delta P_{REF}\ (x) * F_V * F_S * F_Z \qquad (1)$$

The procedure for determining the relief valve setpoint is described below. To illustrate the application of the procedure, a set of sample input parameters will be considered, and the results of the sequential application of each step of the procedure to these parameters will be noted.

PARAMETERS FOR MASS INPUT EXAMPLE

Relief Valve Setpoint	=	500 psig
Relief Valve Opening Time	=	2.0 seconds
Mass Input Rate	=	60 lb/sec
RCS Volume	=	10,000 cu.ft.

Applying the mass input procedure:

Step	Procedure	Example Application
1	Select relief valve setpoint operating range	Setpoint = 500 psig
2	For limiting mass input rate, obtain ΔP_{REF} from Figure 4.2.1	ΔP_{REF} = 82 psi for mass input rate (x) = 60 lb/sec
3	For total RCS volume, obtain F_V factor from Figure 4.2.2	F_V = 0.71 for total RCS volume (V) = 10,000 cu.ft.
4	For the relief valve opening time (total, including delay), obtain F_Z factor from Figure 4.2.3	F_Z = 0.733 for relief valve opening time Z = 2.0 seconds
5	For the relief valve setpoint selected, obtain F_S factor from Figure 4.2.4	F_S = 1.14 for relief valve setpoint = 500 psig
6	Calculate the product of factors ΔP_{REF}, F_V, F_S, and F_Z determined in Steps 2 through 5 (application of Equation 1). This is the setpoint overshoot, ΔP.	ΔP (10,000 cu.ft., 500 psig, 2 seconds, 60 lb/sec) = 49 psi†

† Conservative - LOFTRAN analysis for these conditions gives an overshoot equal to 25 psi.

ation

ss input

CS volume

valve
seconds

valve

) psig,
= 49

oot

FIGURE 4.2.1

Mass Input

ΔP_{REF} - Reference Overshoot

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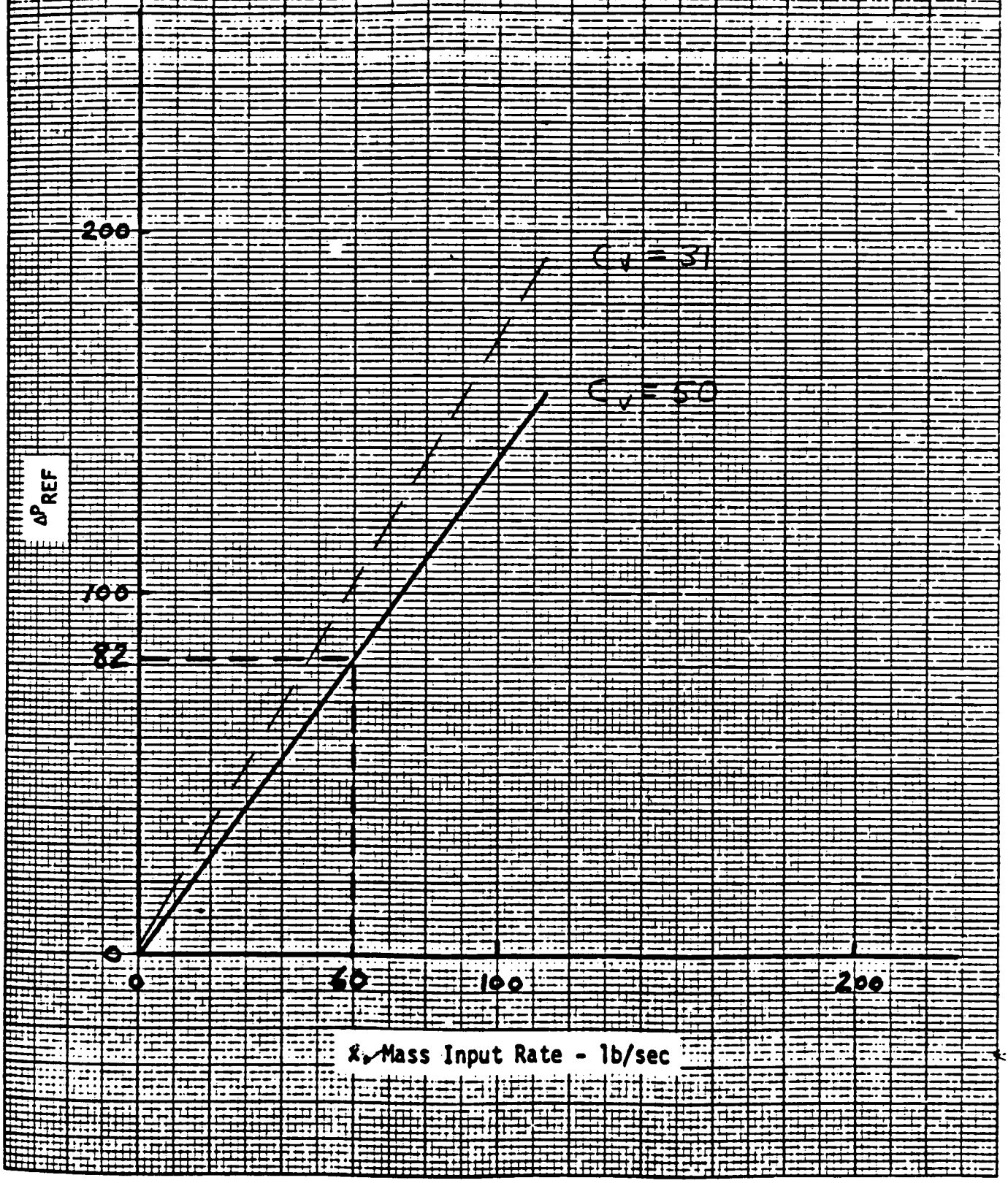

Mass Input

FIGURE 4.2

F_V - RCS Volume Factor

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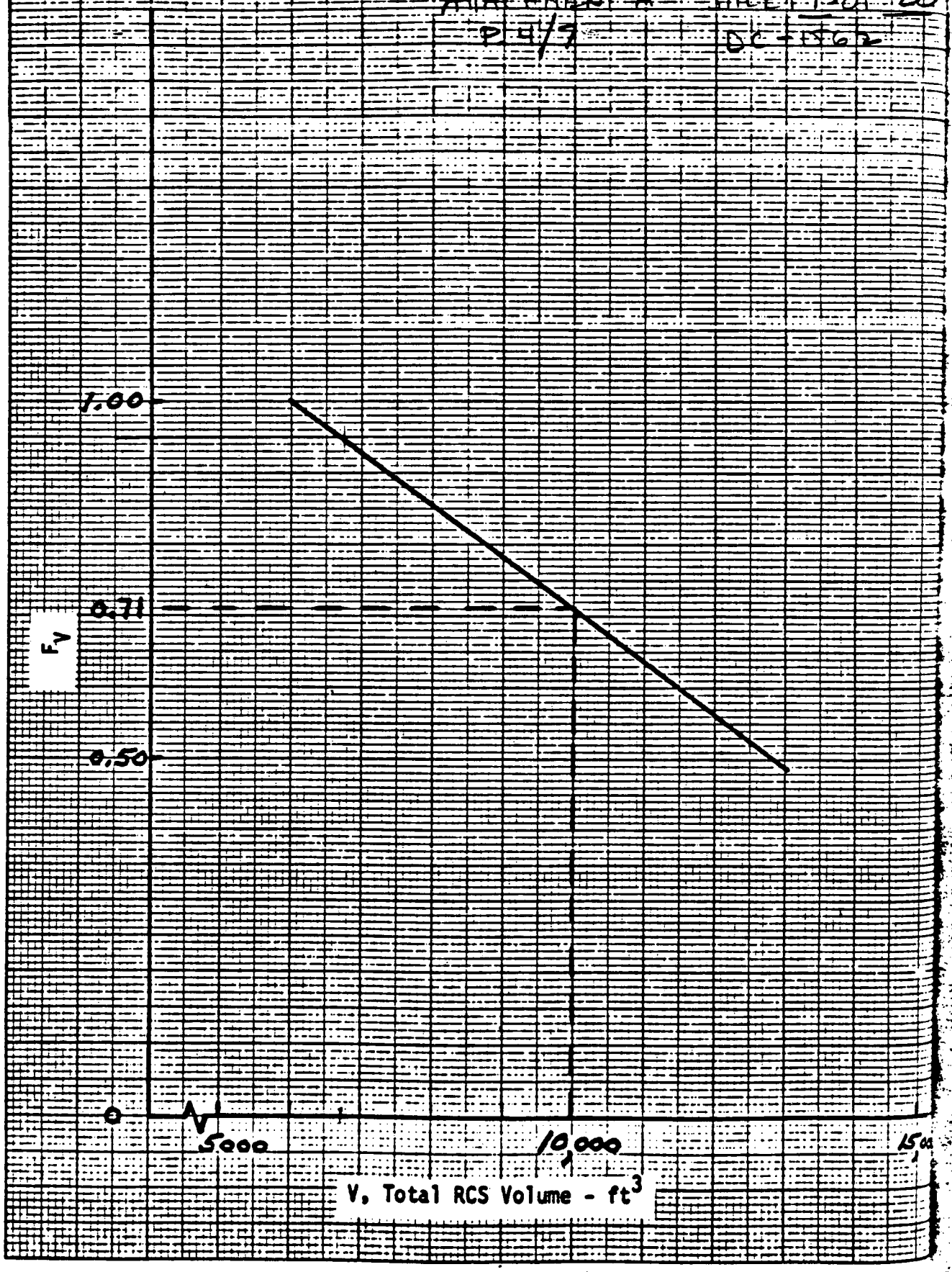

46 1320
K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Z Relief Valve
Opening Time Factor

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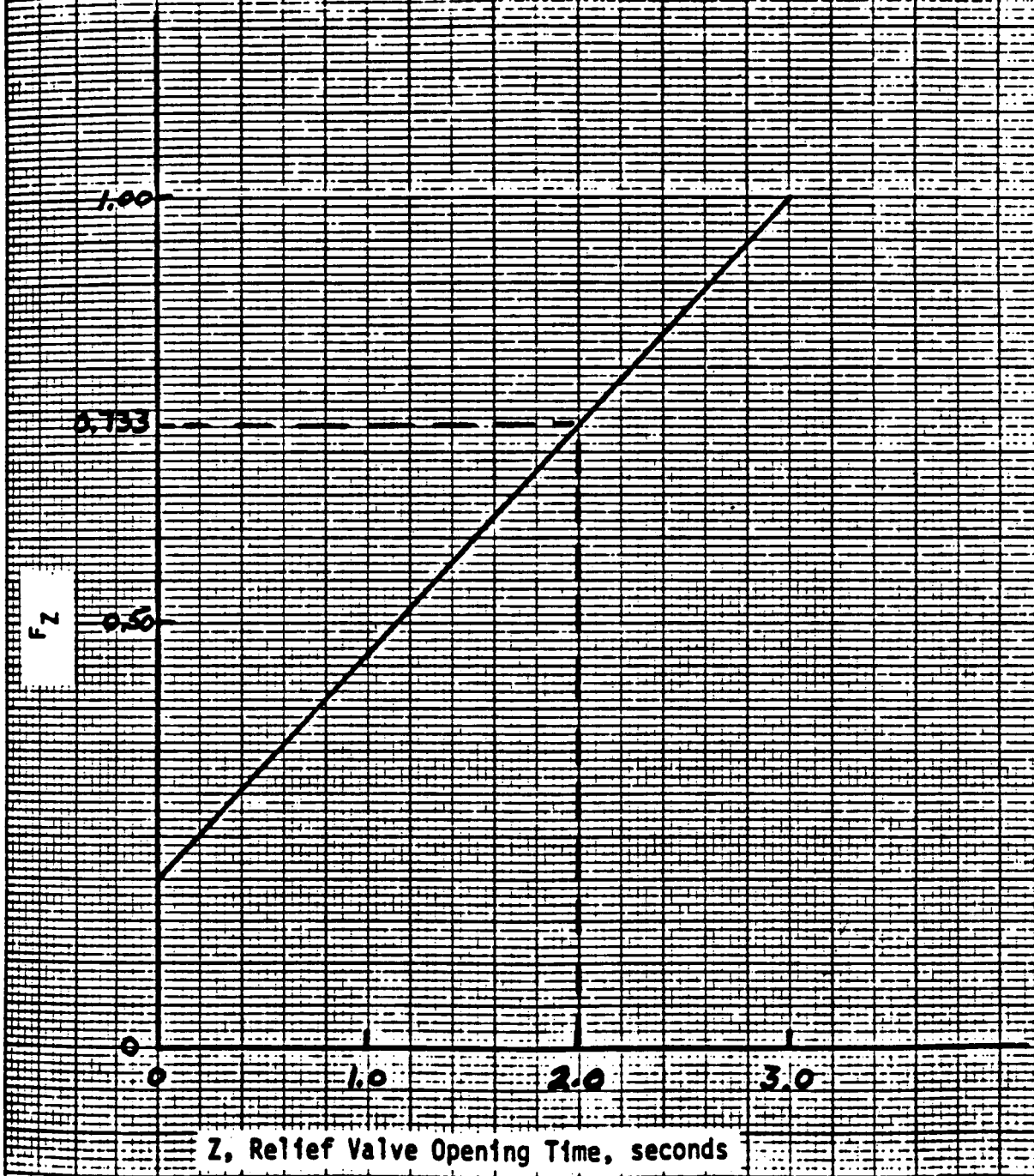
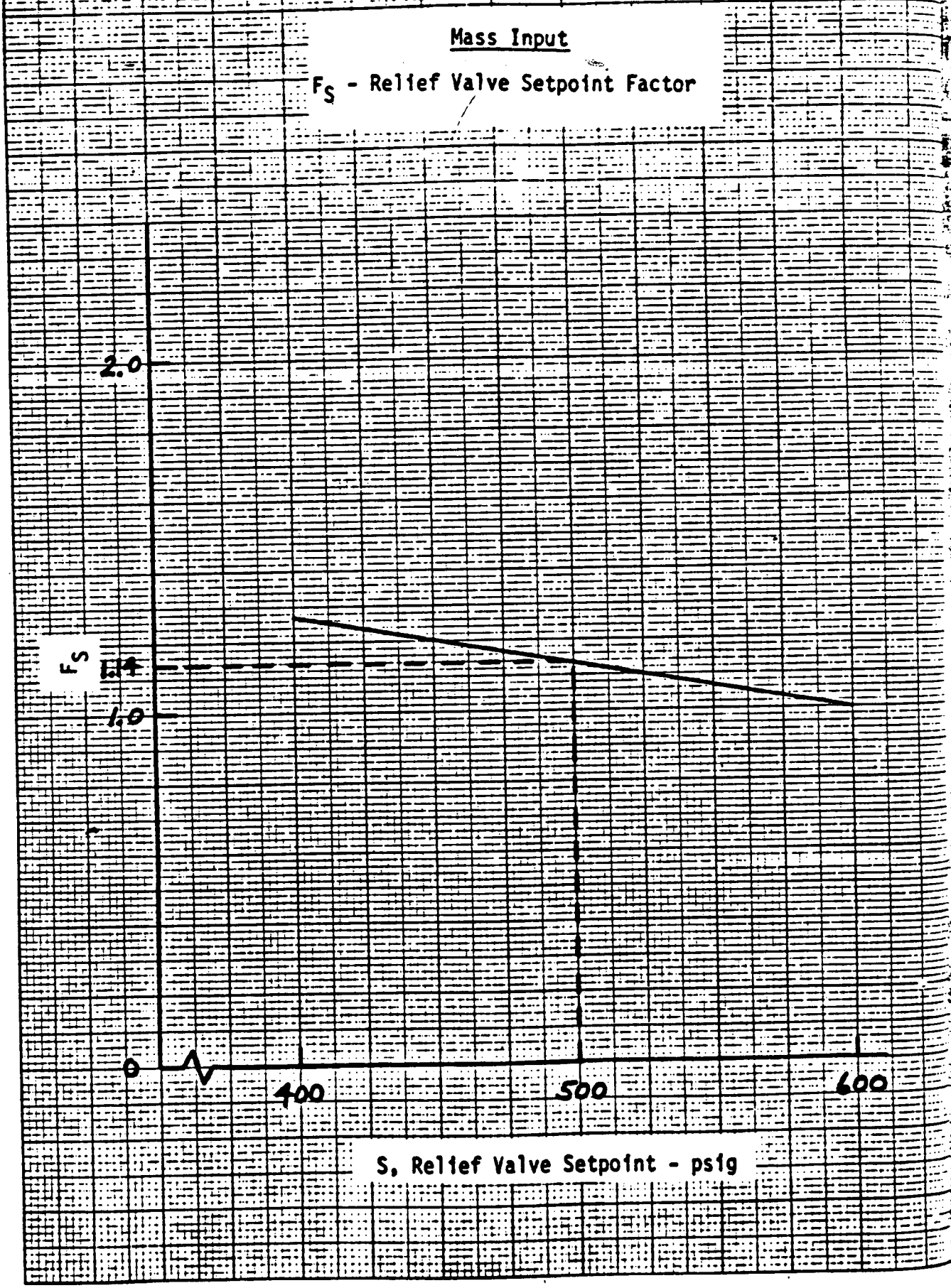


FIGURE 4.2.1



46 1320
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

IGURE 4.2.

Step	Procedure	Example Application
7	Add ΔP (Step 6) to the relief valve setpoint (Step 1) to obtain maximum transient pressure, P_{MAX}. If P_{MAX} < Appendix G limitation, selected relief valve setpoint is acceptable. If P_{MAX} > Appendix G limitation, go to Step 8.	P_{MAX} = 515 psia (relief valve setpoint) plus 49 psi, or 564 psia. From Figure 4.2.5 at RCS temperature = 100°F, Appendix G pressure limit = 540 psig + 15, or 555 psia. Thus, P_{MAX} > Appendix G limitation.
8	If P_{MAX} > Appendix G limitation, selected relief valve setpoint is too high. Reduce setpoint and repeat Steps 5 through 7 until an acceptable setpoint is determined.	Reducing setpoint by 10 psi (564 psia - 555 psia) to 490 psig and repeating Steps 2 through 6 results in ΔP = 49.4 psi and P_{MAX} = 505 psia + 49.4 = 554.4 psia. Since 554.5 psia < Appendix G limit, 490 psig is an acceptable setpoint.

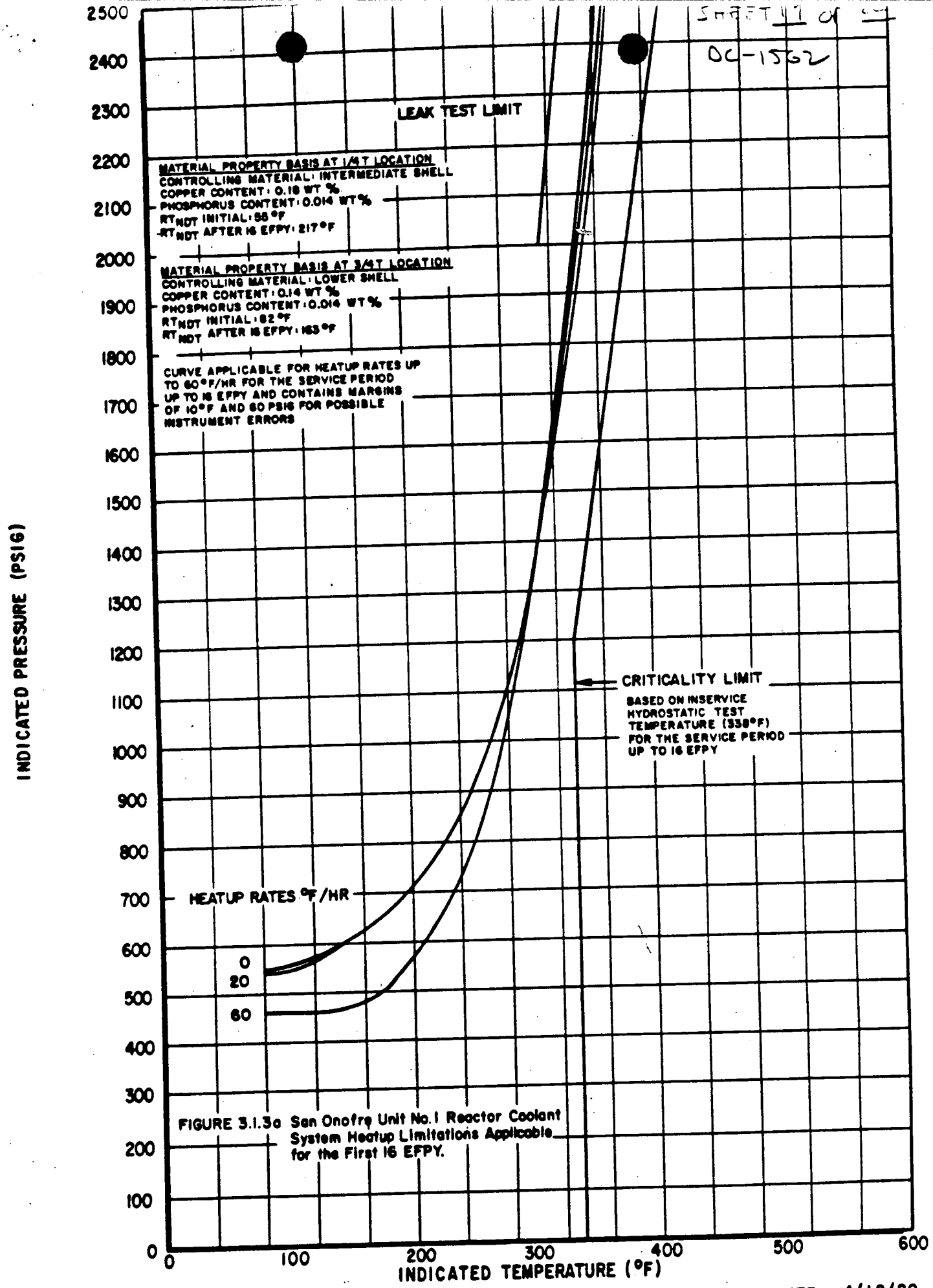


FIGURE 3.1.3a San Onofre Unit No.1 Reactor Coolant System Heatup Limitations Applicable for the First 16 EFPY.

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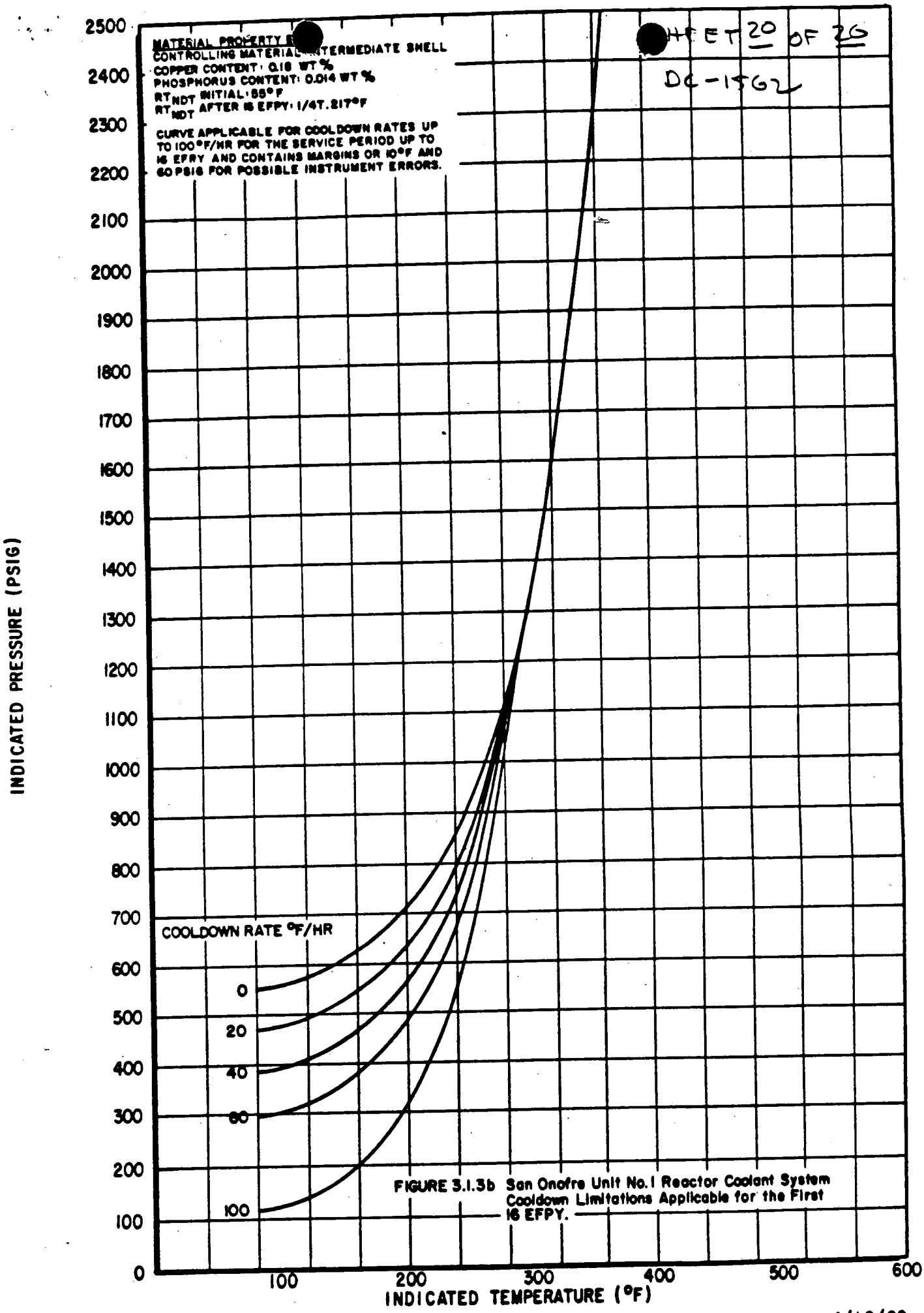

FIGURE 3.1.3b San Onofre Unit No.1 Reactor Coolant System Cooldown Limitations Applicable for the First 16 EFPY.

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