AUG 0 1 1985

Docket No.: 50-206

Mr. Jack Rainsberry, Supervising Engineer
San Onofre Nuclear Generating Station,
Unit 1 Licensing
Southern California Edison Company
P. O. Box 800
2244 Walnut Grove Avenue
Rosemead, California 91770

Dear Mr. Rainsberry:

SUBJECT: LONG TERM SEISMIC CRITERIA AND ANALYSIS METHODS
SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1

As you requested during a conference call on July 31, 1985, attached is a copy of a preliminary evaluation prepared by EG&G Idaho regarding the proposed strain-elastically calculated stress relationship. We request that you review this material in preparation for the meeting scheduled on August 14-15, 1985. If you have any questions regarding this material, please contact Thomas Cheng (301-492-8393).

Original signed by:
C. I. Grimes

Christopher I. Grimes, Chief
Systematic Evaluation Program Branch
Division of Licensing

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Dear Mr. Rainsberry:

SUBJECT: LONG TERM SEISMIC CRITERIA AND ANALYSIS METHODS
SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1

Per your request during a July 31, 1985 Conference Call, attached is a copy of our consultant, EG&G Idaho's, informal evaluation of the proposed strain-elastically calculated stress relationship for you to prepare for the meeting scheduled on August 14-15, 1985. If you have any questions regarding this evaluation, please contact Thomas Cheng (301-492-8393).

Christopher I. Grimes, Chief
Systematic Evaluation Program Branch
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Evaluation of SCE Proposed Strain, Elastic Stress Relationship

SCE has proposed calculating actual strains based on elastically calculated stresses as follows:

given a linear-elastic piping stress:

$$\sigma_E = \frac{PD}{4t} + 0.75i\,(M/Z),$$

calculate a strain by

$$\epsilon = K_s\,\sigma_E / E$$

where

$$K_s = 1.0 \qquad \sigma_E \le S_y$$

$$= 1.0 + \frac{(1-n)}{n(m-1)}\left\{\frac{\sigma_E}{S_y} - 1\right\} \qquad \text{when } S_y \le \sigma_E < mS_y$$

$$= 1/n \qquad \text{when } mS_y < \sigma_E$$

and E = young's modulus

K_s is identical to K_e in NB-3653.6,* "Simplified elastic plastic Discontinuity Analysis", p 131, except that $S_n/3S_m$ is replaced by σ_E/S_y. The K_s, K_e curves are presented on the following page.

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* NB-3653.6 of the ASME B&PV Code, W84 addenda

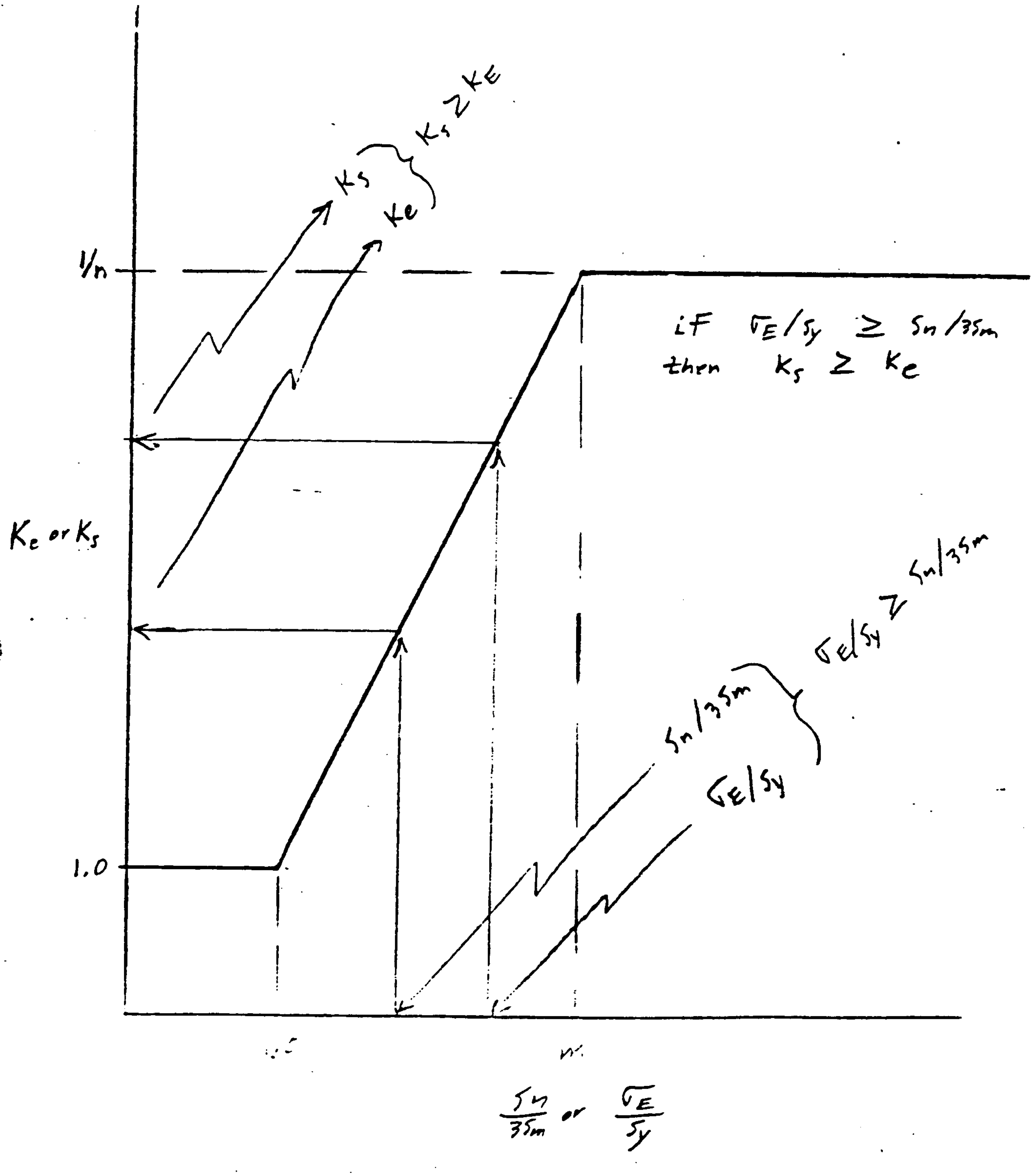

Figure 1. Function relationships: $K_e(S_n/3S_m)$ & $K_s(\sigma_E/S_y)$

Since the K_e expression is acceptable code methodology, and since an investigation of its basis indicates that it is appropriate for use in a seismic calculation, the suitability of the K_s methodology will be based on a comparison to K_e. Given a specific component under a specific loading, both $S_n/3S_m$ and σ_E/S_y can be calculated. Based on the Figure given earlier, $K_s \geq K_e$ only if $\sigma_E/S_y \geq S_n/3S_m$.

since $\sigma_E \geq 0$, $S_y \geq 0$, it follows that $\sigma_E/S_y \geq 0$

and $\dfrac{S_n/3S_m}{(\sigma_E/S_y)} \leq 1$ follows from the above

or $\dfrac{(S_n/\sigma_E)}{(3S_m/S_y)} \leq 1$

The expression has been manipulated to obtain ratios of calculated stress and ratios of allowable stress. This is necessary for the comparison. Based on Table 1, the range of piping materials used in SONGS 1, and their range of operating temperatures, the term $3S_m/S_y$ varies from 1.71 to 2.72. (Note that S_m should be based on Design Temperature according to strict definition.

This was not done due to lack of data, but is essentially neglecting a conservatism of the Code and should be a small error)

The ratio of S_n / σ_E will require a bit more work. From NB-3653.1 of the current ASME Code (W84),

$$S_n = C_1 \frac{P_o D_o}{2t} + \frac{C_2 D_o M_i}{2I} + C_3 E_{ab}\left(\left|\alpha_a T_a - \alpha_b T_b\right|\right)$$

This compares to SCE's σ_E (an ASME Class 2 type of stress):

$$\sigma_E = \frac{PD}{4t} + 0.75i\,(M/Z) \qquad (\text{where } 0.75i \geq 1.0)$$

The assumption that the earthquake load is strongly predominate is made to make the task reasonable. This allows:

1) Neglecting the pressure terms
2) Neglecting the thermal terms
3) setting $M_i = 2M$ (note that Class 1 stresses are stress intensities, and Class 2 stresses are principal stresses)

Under the assumption,

$$\frac{S_n}{\sigma_E} = \frac{\left(\frac{C_2 D_o (2M)}{2I}\right)}{\left(0.75i\left(\frac{M}{Z}\right)\right)}$$

and since $Z = \pi r_m^2 t \approx 2I/D_o$

$$\frac{S_n}{\sigma_E} = \frac{2C_2}{0.75i}$$

Table 2 presents the range of S_n/σ_E calculated for the range of components and sizes which are likely to be found in SONGS 2. Based on table 2, a range of 2.0 to 5.8 has been chosen. Reducers have been neglected in the range because of the disparity in maximum values. The very large ratio for reducers reflects the large allowable variation in geometry, and may not represent the range of reducer geometries in the plant. Based on the chosen range of the stress ratio, the ratio of independent variables $((S_n/\sigma_E)/(3S_m/S_y))$ is (0.74 - 3.39). This shows the proposed methodology to be non-conservative. To correct the situation, the following recommendation is made:

Perform the calculation as proposed, except use $(3.39\,\sigma_E/S_y)$ in calculating K_s. If the component being analyzed is a reducer, use

$S_n/3S_m$ in calculating K_5. Since the 3.39 value is conservative for most components, the option of using $S_n/3S_m$ should also be allowed in all other cases.

Footnote - Since it may be of interest;

-- 0.74 is for straight pipe/girth weld of A312 TP 316 @ 570°F

3.39 is for long radius elbows of carbon steel at low temperature (100°F).

Table 1 Variation in Material Properties for SONGS 1 Piping Materials and Operating Temperatures.

Material	T °F	S_y	S_m	$(3S_m/S_y)$
A312 TP304L	100	25.0	16.7	2.00
	200	21.3	16.7	2.35
TP304	100	30.0	20.0	2.00
	575	18.5	16.7	2.71
TP316	100	30.0	20.0	2.00
	570	19.1	17.3	2.72
A106 Gr B and A53 Gr B (using SA-106)	100	35.0	20.0	1.71
	340	30.6	20.0	1.96
	545	27.2	18.2	2.01
Total Range				(1.71 - 2.72)

Table 2 Variation in Stress Parameters for Typical Piping Components

Component	Range of $2C_2 / max(1.0, 0.75i)$
straight pipe	2.00
girth butt weld	
$t \geq 0.237$ in.	2.00
$t < 0.237$ in.	1.40 to 2.00
girth Fillet weld (socket weld)	~~2.06~~ 2.92 - 4.20
welded transition	2.96
reducers	5.13 to 14.57
LR elbows	5.80
branch connections ("stub" type)	3.04 to 5.33
Forged Tees	4.00 to 5.33
Total Range	2.0 to 5.80

Attachment:

Basis for Table 2 -

$\frac{2c_2}{0.75i}$ ratio

From following pages → C_2, $0.75i$; to Table 2 → $2C_2/0.75i$

Component	C_2	$0.75i$	$2C_2/0.75i$
straight pipe –	1.0	1.0	2.00
girth butt weld			
$t \geq 0.237$	1.0	1.0	2.00
$t \leq 0.237$ †	1.0	1.0 – 1.43	1.40 – 2.00
girth fillet weld † (socket)	2.1	1.0 – ~~1.98~~ 1.44	~~2.66~~ 2.92 – 4.20
welded transition	(1.7 – 2.1)	(1.15 – 1.42)	2.96
reducers	(3.23 – 10.93)	(1.26 – 1.50)	(5.13 – 14.57)
LR Elbows	—	—	5.80
Branches	Calcs complete on following pages		3.04 – 5.33
Forged Tees			4.0 – 5.33

† Primarily small bore

Total Range – (2.0 – 5.8)

From 1983 Code, w 84 Addenda

Table NB-3681(a)-1 (p138) / Fig. NC-3673.2(b)-1, p166

Component	C_2	i	$0.75i$
straight pipe	1.0	1.0	1.0
girth butt weld in str't pipe: $t > 0.237$	1.0	1.0	
$t \le 0.237$	1.0	1.0 to 1.93	1.0 to 1.44
girth fillet weld (socket)	2.1	see below	

NB-3683.5 – Welded Transitions (p142) – C_2 : (1.7 to 2.1) (δ = 0 to ?)

$i = \frac{C_2 K_2}{2}$ ⇒ since $K_2 = 1.8$, i : .9 (1.7 to 2.1) = 1.53 to 1.89

NB-3683.6 – reducers (p142) .75 i ; (1.15 to 1.42)

Population calculation req'd – see following pages (5 thru 9)

Fig NC 3673.2(b)-1 (p167) – socket weld

$i = \max(1.3,\ 2.1/C_x/t_n)$

Fig NC-4427-1 (p251) – socket weld

$C_{x\,min} = 1.09\,t_n$

$i = \max(1.3,\ 2.1/1.09)$
$= 1.93$

range is 1.3 to 1.93

0.75 i ranges from 1.0 to 1.44

NB-3683.7 - elbows - (p143)

$C_2 = 1.95 / h^{2/3}$, but not < 1.5

since $B_2 = 1.30 / h^{2/3}$, but not < 1.5,

$C_2 = 1.5 B_2$

note B_2 lower limit would control limit of C_2 lower limit to be reached ← see p 8

from the B_2 work, the range of $B_2 / 0.75i$ is (1.93) for 3"-30", sch 5S X elbows

therefore, $C_2 / 0.75i = 1.5 (1.93) = 2.90$

$\frac{2C_2}{0.75i} = 5.80$

NB 3683.8 - Branches (p143),

$B_{2b} = 0.5 C_{2b}$, but not < 1.0
$B_{2r} = 0.75 C_{2r}$, but not < 1.0

↑ limit ratios the same

$\therefore$ $C_{2b} = 2.0 B_{2b}$
$C_{2r} = 1.33 B_{2r}$

from the B_{2} work, $B_{2b}/.75i$: (1.00 - 1.33) (ie range from 1 to $1\frac{1}{3}$)
$B_{2r}/.75i$: (1.14 - 1.41) — p9

therefore ($C_{2b}/0.75i$): (2.0 - 2.67)
($C_{2r}/0.75i$): (1.52 - 1.88)
} $\frac{C_2}{.75i}$: (1.52 - 2.67)

$\frac{2C_2}{0.75i} = 3.04 - 5.33$

NB 3683.9 - B.W. Tees - (p 144)

$C_{2b} = 0.67 (R_m / T_r)^{2/3}$ but not ≤ 2.0

$C_{2r} = C_{2b}$

$R_m = r$
$T_r = t$

Fig NC-3673.2 (b)-1 (p166) - for tees

$i = 0.9 / h^{2/3}$

$h = \frac{4.4 t_n}{r}$

r = mean radius
t_n : nominal wall t

mjk 7/19/85

$$0.75i = 0.75\left[\frac{0.9}{\left(\frac{4.4t_n}{r}\right)^{2/3}}\right]$$

$$= \frac{(0.75)(0.9)}{(4.4)^{2/3}}\left(\frac{r}{t_n}\right)^{2/3}$$

$$= 0.257\left(\frac{r}{t_n}\right)^{2/3}$$

$\frac{1}{2} > \frac{1}{3}$

$2 < 3$

← page 3

$$\frac{C_2}{.75i} = 2.665 = 2.67 = \frac{0.67}{0.251}$$

$$\frac{2C_2}{0.75i} = 5.33$$

Eq NC-3673.2(b)4 :- $h = 0.8$ @ $i = 2$ $(h > 0.8,\ i = 1.0)$
(p 170)

~~$h = 0.8 = 4.4t_n/r$~~

~~$r/t_n = 4.4/8$~~

~~$D/t_n = 2(4.4)/8 =$~~

$$h = 4.4t_n/r > 0.8$$

$$r/t_n < 4.4/0.8$$

$$D/t_n < 8.8/0.8 = 11$$

There are components where $D_m/t_n < 11$ ∴

need population calculation (which follows)

↑ pages

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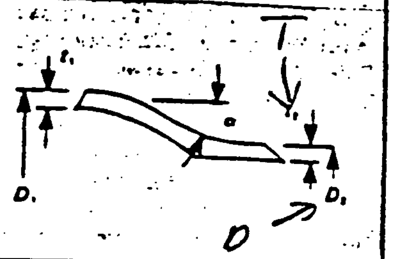
'C₂' Calculation For Reducers

(5)

D_1 (in)	T_1 (in)	D_2 (in)	T_2 (in)	Max(C2S, C2L) $\alpha = 30$	$\alpha = 60$	max(1, 0.75i) $\alpha = 30/60$
3.500	0.216	2.375	0.154	323 2.56	5.47 3.65	1.26 / 1.50
	0.300		0.218	2.90 2.59	4.79 3.19	1.12 / 1.50
6.625	0.280	4.500	0.237	3.70 2.72	6.40 4.27	1.36 / 1.50
	0.432		0.337	3.17	5.35	1.20 / 1.50
	0.280	3.500	0.216	3.70	6.40	1.28 / 1.50
	0.432		0.300	3.17	5.35	1.14 / 1.50
				2.83	4.98	
12.750	0.375	10.750	0.365	(4.24)	(7.47)	(1.50) / (1.50)
	0.500		0.500	3.80	6.60	1.42 / 1.50
	0.375	8.625	0.322	4.24	7.47	1.50 / 1.50
	0.500		0.500	3.80	6.60	1.31 / 1.50
	0.375	6.625	0.280	4.24	7.47	1.47 / 1.50
	0.500		0.432	3.80	6.60	1.26 / 1.50
18.000	0.375	16.000	0.375	4.84	8.69	1.50 / 1.50
	0.500		0.500	4.33	7.66	1.50 / 1.50
	0.375	12.750	0.375	4.84	8.69	1.50 / 1.50
	0.500		0.500	4.33	7.66	1.50 / 1.50
	0.375	10.750	0.365	4.84	8.69	1.50 / 1.50
	0.500		0.500	4.33	7.66	1.42 / 1.50
				3.63	6.59	
24.000	0.375	20.00	0.375	(5.44)	(9.88)	(1.50) / (1.50)
	0.500		0.500	4.84	8.69	1.50 / 1.50
	0.375	18.000	0.375	5.44	9.88	1.50 / 1.50
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
	0.375	16.000	0.375	5.44	9.88	1.50 / 1.50
	0.500		0.500	4.84	8.69	1.50 / 1.50
				3.97	7.29	
30.000	0.375	28.000	0.375	(5.96)	(10.93)	(1.50) / (1.50)
	0.500		0.500	5.30	9.60	1.50 / 1.50
	0.375	24.000	0.375	5.96	10.93	1.50 / 1.50
	0.500		0.500	5.30	9.60	1.50 / 1.50
	0.375	20.000	0.375	5.96	10.93	1.50 / 1.50
	0.500		0.500	5.30	9.06	1.50 / 1.50

range of $\frac{C_2}{.75i}$ is 2.56 (α = 30, 3" sch 40) to 7.29 (α = 60, 30" sch 5) $\Rightarrow \frac{2C_2}{0.75}$: 5.13 to 14.57

Description	Flexibility Factor k	Stress Intensification Factor i	Sketch
Concentric and eccentric reducers [Note (7)] (ANSI B16.9)	1	2.0 max. or $0.5 + 0.01\alpha\left(\frac{D_2}{t_2}\right)^{1/2}$ (D, T)	

$$.75i = \max[1.0, .75[\min(2.0, 0.5 + 0.01\alpha(D/T)^{1/2})]]$$

```
**********

   A = 2.375

**********

   A = 30.000
   D = 2.375

   T = 0.154
.75I = 1.259

   T = 0.218
.75I = 1.118


01◆LBL "RDI"
02 ADV
03 ADV
04 "**********"
05 PRA
06 ADV
07 "   A = "
08 CF 01
09 XEQ "IO"
10 STO 01
11◆LBL 01
12 "   D = "
13 XEQ "IO"
14 STO 02
15 ADV
16◆LBL 02
17 RCL 02
18 "   T = "
19 XEQ "IO"
20 /
21 SQRT
22 RCL 01
23 *
24 .0075
25 *
26 .375
27 +
28 1.5
29 X>Y?
30 X<>Y
31 1.0
32 X<=Y?
33 X<>Y
34 ".75I = "
35 ARCL X
36 PRA
37 ADV
38 FIX 01
39 STOP
40 SF 01
41 GTO 02
42◆LBL "IO"
43 PROMPT
44 ARCL X
45 PRA
46 RTN
47 END
```

MJR 7/10/85

1983 Edition, W54, p 143 — ASME B&PV — NB-3000

(7)

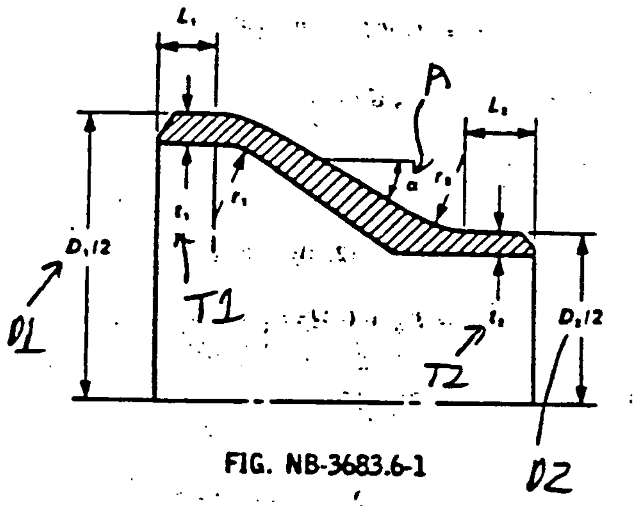


FIG. NB-3683.6-1

(1) For reducers with r_1 and $r_2 \geq 0.1\,D_1$:

$$C_1 = 1.0 + 0.0058\;\alpha\sqrt{D_n/t_n}$$

$$C2L = C_2 = 1.0 + 0.36\;\alpha^{0.4}\,(D_n/t_n)^{0.4(D_2/D_1 - 0.5)}$$

where D_n/t_n is the larger of D_1/t_1 and D_2/t_2.

(2) For reducers with r_1 and/or $r_2 < 0.1D_1$:

$$C_1 = 1.0 + 0.00465\;\alpha^{1.285}\,(D_n/t_n)^{0.39}$$

$$C2S = C_2 = 1.0 + 0.0185\;\alpha\sqrt{D_n/t_n}$$

where D_n/t_n is the larger of D_1/t_1 and D_2/t_2.

```
01+LBL "RDC"
02 FIX 3
03 ADV
04 ADV
05 "C2: REDUCER"
06 PRA
07 ADV
08 "  A = "
09 XEQ "IO"
10 STO 01
11 " D1 = "
12 XEQ "IO"
13 STO 02
14 " T1 = "
15 XEQ "IO"
16 STO 03
17+LBL 01
18 ADV
19 ADV
20 " D2 = "
21 XEQ "IO"
22 STO 04
23 " T2 = "
24 XEQ "IO"
25 STO 05
26 RCL 02
27 RCL 03
28 /
29 RCL 04
30 RCL 05
31 /
32 X<=Y?
33 X<>Y
34 STO 06
35 [illegible]
36 RCL 02
37 /
38 .5
39 -
40 .4
41 *
42 RCL 06
43 X<>Y
44 Y↑X
45 RCL 01
46 .4
47 Y↑X
48 *
49 .36
50 *
51 1
52 +
53 "C2L = "
54 ARCL X
55 PRA
56 RCL 06
57 SQRT
58 RCL 01
59 *
60 .0185
61 *
62 1
63 +
64 "C2S = "
65 ARCL X
66 PRA
67 GTO 01
68+LBL "IO"
69 PROMPT
70 ARCL X
71 [illegible]
72 RTN
73 END
```

```
C2: REDUCER

  A = 30.000
 D1 = 6.625
 T1 = 0.280


 D2 = 4.500
 T2 = 0.237
C2L = 2.761
C2S = 3.700


 D2 = 3.500
 T2 = 0.216
C2L = 2.454
C2S = 3.700
```

```
C2: REDUCER

  A = 60.000
 D1 = 6.625
 T1 = 0.280


 D2 = 4.500
 T2 = 0.237
C2L = 3.323
C2S = 6.395


 D2 = 3.500
 T2 = 0.216
C2L = 2.915
C2S = 6.395
```

	2"	3"	4"	6"	12"	18"	24"	30"
D0	2.37[illegible]	3.5000	4.5000	6.6250	12.7500	18.0000	24.0000	30.0000
LR elbows → R	3.0000	4.5000	6.0000	9.0000	18.0000	27.0000	36.0000	45.0000
Std → TH	0.15[illegible]	0.2160	0.2370	0.2800	0.3750	0.3750	0.3750	0.3750
ELBOW R:B1	0.[illegible]	0.0884	0.0504	0.0003	0.0000	0.0000	0.0000	0.0000
ELBOW R:B2	1.[illegible]	1.9259	1.9259	1.9259	1.9259	1.9259	1.9259	1.9259
TEE R:B2B	1.4[illegible]	1.5465	1.5911	1.5911	1.5911	1.5911	1.5911	1.5911
TEE R:B2R	1.[illegible]	1.9331	1.9889	1.9889	1.9889	1.9889	1.9899	1.9889
X5 → TH	0.21[illegible]	0.3000	0.3370	0.4320	0.5000	0.5000	0.5000	0.5000
ELBOW R:B1	0.24[illegible]	0.2215	0.1734	0.1244	0.0000	0.0000	0.0000	0.0000
ELBOW R:B2	1.[illegible]	1.9259	1.9259	1.9259	1.9259	1.9259	1.9259	1.9259
TEE R:B2B	1.1[illegible]	1.2210	1.3466	1.4870	1.5911	1.5911	1.5911	1.5911
TEE R:B2R	1.45[illegible]	1.5263	1.6832	1.85[illegible]	1.9889	1.9889	1.9889	1.9889

Elbows: $B_2/0.75i$

Branch Dia	sch	Indice	Run Diameter (schedule same as Branch piping) 4	6	8	10	12	14	16	18	24	30	max	min
2"	40	Br	1.33	1.33	1.33	1.33	1.33	1.24	1.02	1.00	1.00	1.00	1.33	1.00
		Rn	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
4"	40	Br	X	X	1.33	—	—	—	—	—	—	1.33	1.33	1.33
		Rn			1.33	—	—	—	—	—	—	1.33	1.33	1.33
6"	40	Br	X	X	X	X	1.33	—	—	—	—	1.33	1.33	1.33
		Rn					1.41	—	—	—	—	1.41	1.41	1.41
2"	80	Br	1.33	1.33	1.24	1.00	—	—	—	—	—	1.00	1.33	1.00
		Rn	1.14	1.14	1.14	1.14	—	—	—	—	—	1.14	1.14	1.14
4"	80	Br	X	X	1.33	—	—	1.33	1.26	1.08	1.00	1.00	1.33	1.00
		Rn			1.21	—	—	—	—	—	—	1.21	1.21	1.21
6"	80	Br	X	X	X	X	1.33	—	—	1.33	1.151		1.33	1.15
		Rn					1.25	—	—	—	1.25		1.25	1.25

total -
Br - 1.33 - 1.00
Rn - 1.41 - 1.14

For branches

B_{2b}/0.75i
B_{2r}/0.75i

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(10)

TEE CIF

nominal Ø"	Sch 5	Sch X
2½	D = 2.8750 T = 0.2030 C2 = 2.3530 .75I = 1.0000 RAT = 2.3530	D = 2.8750 T = 0.2760 C2 = 2.0000 .75I = 1.0000 RAT = 2.0000
3	D = 3.5000 T = 0.2160 C2 = 2.5903 .75I = 1.0000 RAT = 2.5903	D = 3.5000 T = 0.3000 C2 = 2.0452 .75I = 1.0000 RAT = 2.0452
3½	D = 4.0000 T = 0.2260 C2 = 2.7575 .75I = 1.0346 RAT = 2.6653	D = 4.0000 T = 0.3180 C2 = 2.1602 .75I = 1.0000 RAT = 2.1602
4	D = 4.5000 T = 0.2370 C2 = 2.8976 .75I = 1.0872 RAT = 2.6653	D = 4.5000 T = 0.3370 C2 = 2.2555 .75I = 1.0000 RAT = 2.2555
6	0 0 0	D = 6.6250 T = 0.4320 C2 = 2.4908 .75I = 1.0000 RAT = 2.4908
8	0 0 0	D = 8.6250 T = 0.5000 C2 = [illegible] .75I = [illegible] RAT = 2.6653
	0 0 0	0 0 0
	D = 30.0000 T = 0.3750 C2 = 7.7709 .75I = 2.9156 RAT = 2.6653	D = 30.0000 T = 0.5000 C2 = 6.7967 .75I = 2.4000 RAT = 2.6653

$\frac{C_2}{0.75i}$ ranges from 2.00 to 2.67 (2½" sch X → 30" sch both)

$\frac{2C_2}{0.75i}$ ranges from 4.0 to 5.34

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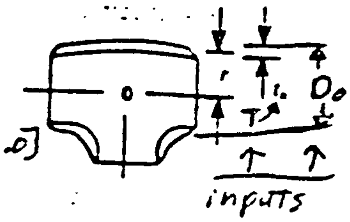
Fig. NC-3673.2(b)-1

SECTION III, DIVISION 1 — SUBSECTION NC

W84 (11)

1983 Edition

Description	Flexibility Characteristic h	Flexibility Factor k	Stress Intensification Factor i	Sketch
Welding tee per ANSI B16.9 [Notes (1), (2)]	$\frac{4.4\ t_n}{r}$	1	$I = \frac{0.9}{h^{2/3}}$ $.75I = \max[.75I, 1.0]$	

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NB-3683.8–NB-3683.9

W84

1983 Edition

Register	Contents
1	$I_n = T_r$
2	$r = R_m$
3	

(b) *Primary Plus Secondary Stress Indices.* The C_{2b} and C_{2r} stress indices for moment loadings [see NB-3683.1(d)] shall be taken as:

$$C_{2b} = 0.67\ (R_m/T_r)^{2/3} \text{ but not } < 2.0$$

$$C_{2r} = 0.67\ (R_m/T_r)^{2/3} \text{ but not } < 2.0$$

$$\underline{CZ} = C_{2b} = C_{2r}$$

$$r = R_m = \tfrac{1}{2}(D_o - T)$$

$$\underline{RAT} = C_2/(0.75I)$$

```
01♦LBL "TEE"
02 "   TEE SIF"
03 PRA
04♦LBL 01
05 ADV
06 ADV
07 "   D = "
08 XEQ "IO"        <- D
09 "   T = "
10 XEQ "IO"        <- T
11 STO 01
12 -
13 2
14 /
15 STO 02
16 RCL 01
17 /
18 2
19 ENTER↑
20 3
21 /
22 Y↑X
23 .67
24 *
25 2
26 X<=Y?
27 X<>Y
28 STO 03
29 "   C2 = "
30 ARCL X
31 XEQ "PRA"   -> CZ
32 .675
33 RCL 01
34 4.4
35 *
36 RCL 02
37 /
38 2
39 ENTER↑
40 3
41 /
42 Y↑X
43 /
44 1
45 X<=Y?
46 X<>Y
47 ".75I = "
48 ARCL X
49 XEQ "PRA"   -> .75I
50 RCL 03
51 /
52 1/X
53 " RAT = "   -> RAT
54 ARCL X
55 XEQ "PRA"
56 GTO 01
57♦LBL "IO"
58 PROMPT
59 ARCL X
60 XEQ "PRA"
61 RTN
62 STOP
63 END
```

```
      TEE SIF

RAT        <- Do
-> D = 18.0000
-> T = 0.3750
  C2 = 5.4969 ->
.75I = 2.0624 ->
 RAT = 2.6653 ->

-> D = 3.5000
-> T = 0.6000
  C2 = 2.0000 ->
.75I = 1.0000 ->
 RAT = 2.0000
```

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