UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICE OF THE SECRETARY

June 4, 1979

MEMORANDUM FOR THE RECORD

FROM: Samuel J. Chilk, Secretary

SUBJECT: BRIEFING ON SHUTDOWN - PIPE STRESS ISSUE AT BEAVER VALLEY, 1:50 P.M., WEDNESDAY, MAY 30, 1979, COMMISSIONERS' CONFERENCE ROOM, D.C. OFFICE (OPEN TO PUBLIC ATTENDANCE)

The Commission* received a status report by representatives of NRR on seismic reanalysis matters.

Although the Commission took no action on this matter, they did note that subsequent briefings on seismic reanalysis matters would be scheduled in the near future.

cc: Public Document Room

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* Commissioner Ahearne was not in attendance.

B-20

STONE & WEBSTER ENGINEERING CORPORATION

ENGINEERING DIVISION MEMORANDUM NO. EMD-79-11 REV. 2

ENGINEERING MECHANICS DIVISION

SUBJECT: STRESS INTENSIFICATION FACOTRS AND STRESSES FOR REDUCED OUTLET BRANCH CONNECTIONS (ANSI B31.1 AND ASME SECTION III CLASS 2 & 3)

DATE: June 8, 1979

FROM: RPWessel

TO: ALL HOLDERS OF EMD GUIDELINES

CC

1.0 Purpose

The purpose of this memorandum is to provide criteria for the determination and application of the Stress Intensification Factors (SIF) that are to be used at reduced outlet branch connections in the course of piping analysis when the rules of ANSI B31.1 or ASME Section III Class 2 or Class 3 are applicable.

2.0 Application

2.1 SIF Values Provided by the Codes

In the application of the rules of B31.1 and Section III, Classes 2 and 3 to the analysis of pipe branch connections, each of the three legs at a branch connection shall be checked individually for stress magnitudes.

Each branch connection has one unique SIF associated with it and this SIF is applied to each of the three legs at the branch connection.

The expressions for the SIF's are presented in the tables of Appendix D in ANSI B31.3b, 1973 and in Tables NC/ND-3673.2(b)-1 of Section III. The application of the rules of B31.1 prior to B31.1b, 1973 are discussed in Appendix A of this document.

> PIPING ANALYSIS PROGRAMS PSTRESS AND SHOCK REPORT INCORRECT STRESSES AT REDUCED OUTLET BRANCH CONNECTIONS DUE TO AN ERROR IN THE DETERMINATION OF THE SIF.
>
> APPENDIX A OF THIS DOCUMENT PROVIDES A METHOD FOR DETERMINING THE CORRECT STRESS AT REDUCED OUTLET BRANCH CONNECTIONS WHERE PSTRESS OR SHOCK PROGRAMS WERE USED. THE CORRECTIONS OF APPENDIX A MUST BE MADE MANUALLY TO ALL PSTRESS AND SHOCK RUNS THAT CONTAIN REDUCED OUTLET BRANCH CONNECTIONS.

The values of SIF are dependant upon the run pipe dimensions and independant of the branch pipe dimensions for three of the four types of branch connections covered by the Code Tables. These are the ANSI B16.9 welding tee, the reinforced fabricated tee with pad or saddle, and the unreinforced fabricated tee.

There is one other type of branch connection covered by the Code Tables, i.e. the "nozzle" type where the added reinforcement material is placed on the branch member rather than on the run. The SIF for this type is dependant upon both the run pipe and branch pipe dimensions. This branch connection is limited in its application in that it is restricted to branch/run ratios of about one half, and must have certain defined corner and fillet radii.

In the course of piping analysis using NUPIPE, the SIF values are determined internally in the program for those four branch connections that are given in the Code Tables.

2.2 Additional Acceptable SIF Values

Since the development of the above SIF's, some additional SIF's have become available. At the present time, the additional components for which SIF's are known are "WELDOLETS", "SOCKOLETS", and "LATROLETS" manufactured by Bonney Forge Corporation.

When the piping system being analyzed contained "WELDOLETS", "SOCKOLETS" or "LATROLETS" the SIF values must be determined by the analyst and these SIF's must be manually coded into the SIF field of the TEE card of NUPIPE (see the NUPIPE users manual 3.8.3.1h). The expressions for these SIF's are given below.

2.2a "WELDOLETS"

$$i = \frac{0.9}{h^{2/3}} \text{, but not less than 1.0}$$

$$h = 3.3\frac{\bar{T}}{r_2}$$

$\bar{T}$ = Nominal thickness of the run pipe (in).

r_2 = Mean radius of the run pipe (in).

2.2b "SOCKOLETS"

Same as for "WELDOLETS". Since these fittings also have socket welded attachments, the NUPIPE user must also designate an SRUN member on the branch in the vicinity of the physical location of the socket weld.

2.2c "LATROLETS"

"LATROLETS" due to their shape have two values for the SIF. One value applies to in plane bending, and the other to out of plane bending. Since NUPIPE accepts only one value of SIF and the out of plane value is always the larger, this value must be used:

$$i_o = \frac{0.9}{h^{2/3}}, \text{ but not less than } 1.0$$

$$h = 1.97\frac{\bar{T}}{r_2}$$

Subscript "o" designates out of plane.

For the sake of completeness the SIF expression for in plane bending is also provided:

$$i_i = \frac{0.9}{h^{2/3}}, \text{ but not less than } 1.0$$

$$h = 3.05\frac{\bar{T}}{r_2}$$

Subscript "i" designates in plane

"LATROLETS" are made with an without socket weld ends. Where socket welds are provided, the NUPIPE user must designate an SRUW member on the branch in the vicinity of the physical location of the socket weld.

2.3 Some Numerical Values of SIF's

There may be cases when the user must calculate stresses at branch connections manually. Some values of SIF's are provided in the attachments to this document. These attachments are:

Attachments 1, 1A and 1B

- Type A - ANSI B16.9 welding tee
- Type B - Unreinforced fabricated tee
- Type C - Reinforced fabricated tee with the reinforcement thickness equal to the pipe thickness
- Type D - Reinforced fabricated tee with the reinforcement thickness equal to 1.5 times the run pipe thickness.

Attachment 2

"WELDOLETS" and "SOCKOLETS"

Attachment 2A

"LATROLETS"

Attachments 3 and 3A

"Nozzle type connections. Nomenclature, limitations, and the expression for SIF

2.4 Small Branch Connection SIF's

It is recognized that there are cases where small branch connections are made to relatively large run pipes. In these cases it is obvious that the moment load that can be introduced into the connection through an applied moment on the branch pipe is small and, in most cases, the presence of a small branch connection has a negligible effect on the run pipe. Assuming that there is a lower limit to the ratio r'_m/R_m (r'_m and R_m are the mean radii of the branch pipe and the run pipe respectively) below which the presence of a branch has a negligible influence on the run pipe stresses. This lower limit should be expressable in terms of r'_m and R_m.

One acceptable approach to defining this lower limit and reduced influence is to use the expression for the primary plus secondary membrane plus bending stress index, C_{2r}, that is applied to the run moments of an integrally reinforced brahcn connection in the analysis of class 1 Nuclear Components. This expression is given in Section III, Table nb-3682.2-1. Note 7, and is:

$$C_{2r} = 0.8(R_m/T_r)^{2/3}(r'_m/R_m), \text{ but not less than } 1.0$$

R_m = Mean radius of the run pipe (in)

T_r = Nominal thickness of the run pipe (in)

r'_m = Mean radius of the branch pipe (in).

By setting $C_{2r} \leq 1.0$ and transposing:

$$r'_m \leq (R_m/T_r)^{-2/3}(R_m/0.8)$$

This value of r'_m is the maximum value of branch pipe mean radius for which no SIF need be applied to the run pipe moments.

There are some common pipe sizes listed in Attachment 4 to this document along with their maximum values of Mean Branch Pipe Diameter and equivalent branch pipe sizes for which no SIF need be applied to the run pipe.

2.5 Stress Determination

Finally a note on the determination of branch member stress. This stress is determined using an "effective" section modulus for the branch member as follows:

$$S_b = \frac{iM_b}{Z_b}$$

i = SIF for the branch connection *

M_b = Resultant branch moment (in lb)

Z_b - Effective section modulus of the reduced outlet branch, $(in)^3$

$$Z_b = (r_b)^2 t_s$$

r_b = Mean radius of the branch pipe, (in)

t_s = Effective branch thickness, taken as the lesses of (t_r) or (it_b), (in)

t_b = Nominal branch pipe thickness, (in)

t_r = Nominal run pipe thickness, exclusive of reinforcing material, (in).

This concept of "effective" section modulus applies only at the reduced outlet branch. All other stress calculations must use the nominal section modulus.

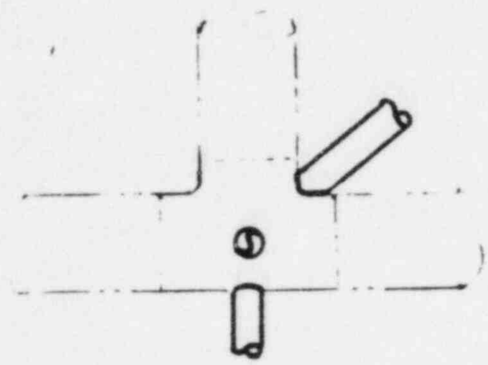
* The SIF for a branch connection as covered throughout this memorandum is associated with and applied to each of the three legs of a branch connection at the intersection point of the three legs. Special attention is required when the branch connection is fabricated by means of a fitting such as a "SOCKOLET" where the branch pipe connection is made with a socket weld. The SIF for a socket weld ($i = 1.3$) must be applied to the branch line immediately adjacent to the branch connection. This must be done in addition to the branch connection analysis.

3.0 Unacceptable Branch Connections

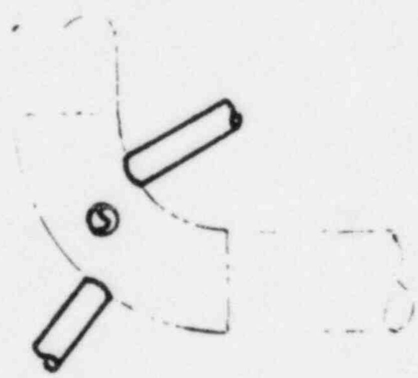
There are a number of branch connection configurations for which there are no existing SIF values. These branch connections are not acceptable for use in B31.1 or Section III Classes 2 and 3 piping systems.

Some examples of unacceptable branch connections (shown in solid line) are:

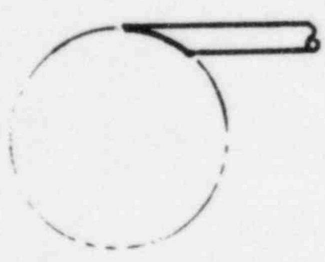
3.1 Branch Connections on Branch Connections



3.2 Branch Connections to Elbows and Bends

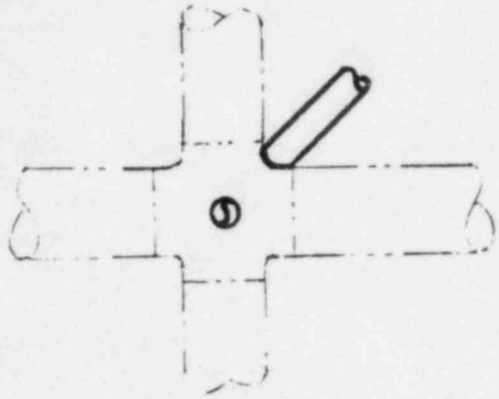


3.3 Hillside Connections



3.4 Branch Connections to Crosses

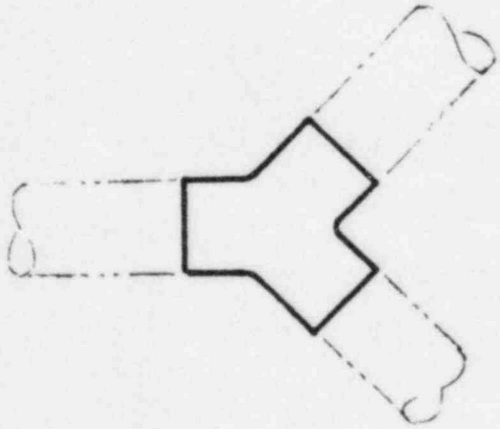
Even though crosses are covered by ANSI B16.9, there is no acceptable method for determining SIF values.



3.5 Laterals

"Stub in" are unacceptable; however, Bonney Forge "LATROLETS" with proper SIF values are acceptable, see 2.2c.

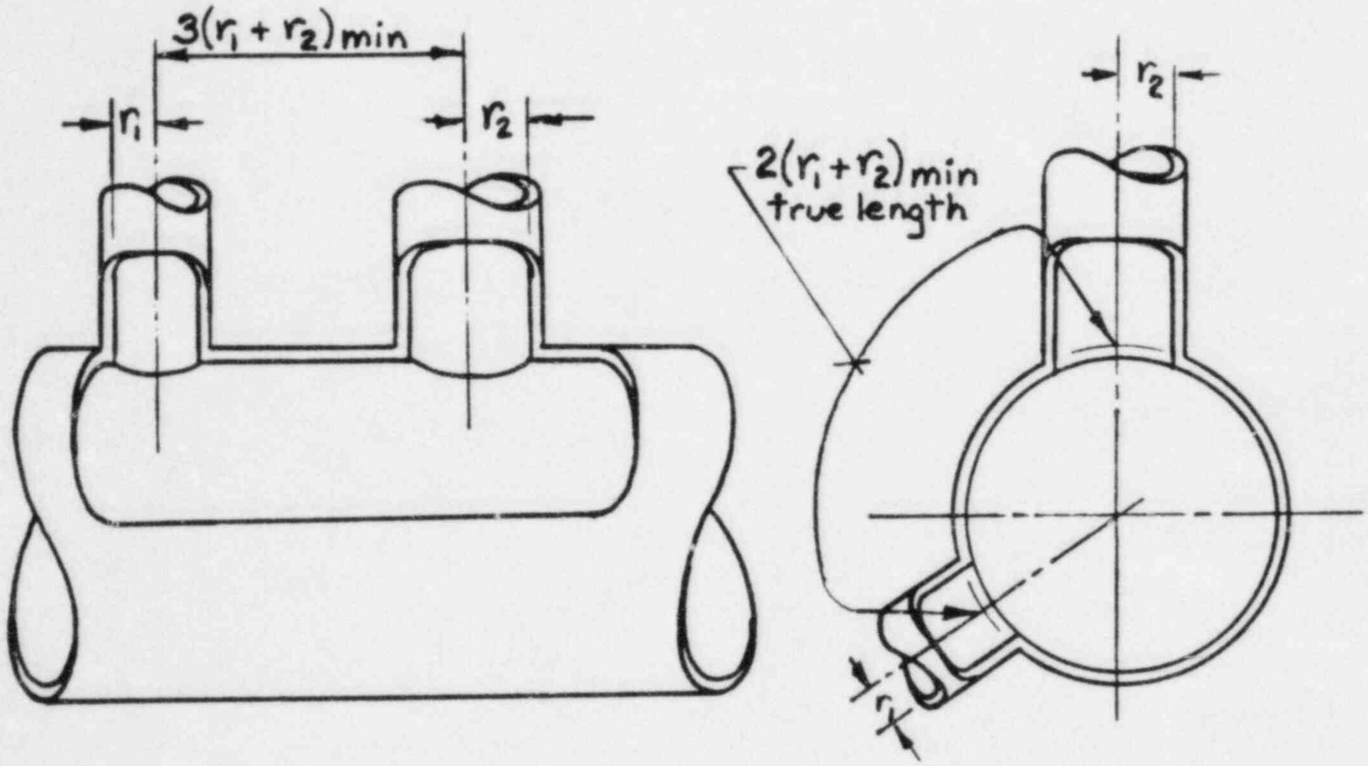
3.6 Wyes



3.7 Dimensional Limitations

Finally, the following dimensional rules must be applied at branch connections.

For multiple branch connections on a pipe, the arc distance measured between the centers of adjacent branches along the surface of the run pipe shall be not less than three times the sum of their inside radii in the longitudinal direction and not less than two times the sum of their inside radii along the circumference of the run pipe.



R.P. Wessel

R.P. Wessel
Chief Engineer

APPENDIX A

SUBJECT: CORRECTION OF STRESS AT REDUCED OUTLET BRANCH CONNECTIONS THAT WERE EVALUATED USING THE PSTRESS AND SHOCK PROGRAMS

1.0 Scope

The PSTRESS and SHOCK programs were superseded by NUPIPE prior to the B31.1b, 1973 edition of the ANSI Power Piping Code which was issued on 30 June 1973. The correction of PSTRESS and SHOCK stresses will therefore be based upon ANSI B31.1 prior to the above edition.

THESE CORRECTIONS MUST BE MADE TO ALL REDUCED OUTLET BRANCH CONNECTIONS THAT WERE EVALUATED USING THE PSTRESS AND SHOCK PROGRAMS

2.0 Application

In the reevaluation of reduced outlet branch connection stresses, only the branch member stresses need be reevaluated.

This reevaluation can be accomplished by any one of the following three steps:

Step 1. $S = S_1\left[\frac{i}{i_1}\right]$

S = Corrected Stress

S_1 = Stress value from PSTRESS or SHOCK

i = SIF as determined in the body of this memorandum

i_1 = SIF from the PSTRESS or SHOCK run .

Step 2. Where the stresses determined in Step 1 exceed the allowable stresses, a second more precise evaluation can be made:

$$S = \left[\frac{(i)^2 + (a)^2}{(i_1)^2 + (a)^2}\right]^{\frac{1}{2}}$$

a = The ratio of torsional moment to bending moment for the branch member

$$a = \frac{(M_T^b)}{\left[(M_I^b)^2 + (M_o^b)^2\right]^{\frac{1}{2}}}$$

M = Component of moment (in·lb)

Superscript "b" denotes branch member
Subscript "i" denotes in plane
Subscript "o" denotes out of plane

Step 3. Alternatively the branch moments may be extracted from PSTRESS or SHOCK and the more precise stresses determined in the manner shown below.

3.0 Calculation of Stresses Based on B31.1 Prior to the 30 June 1973 Edition

The values of SIF are the same as those in the body of this memorandum; the application of the SIF values is somewhat different.

The moments that apply to a branch connection are evaluated from a unique orthogonal point of view, described as in plane bending, out of plane bending and torsion.

To describe in plane bending, let the three legs of the branch connection describe a plane called the plane of the component. A line through the intersection of the three legs and perpendicular to the plane of the component describes the axis of in plane bending.

Torsion is self explanatory; each leg describes its torsional axis.

To describe the out of plane axis for either of the run pipe members, the in plane axis of the component and the torsional axis of the run pipe form two mutually perpendicular axes. The out of plane axis for the run pipe is described by these two axes and the right hand rule.

The out of plane axis for the branch pipe member is described in the same way, using the in plane bending axis of the component and the torsional axis of the branch pipe with the right hand rule.

The basic SIF is determined as in the body of this memorandum. The value of the SIF (i) applies to the out of plane bending moment.

A new value (i') is determined as

$$i' = 0.75i + 0.25$$

This value (i') applies to the in plane bending moment. There is no SIF applied to the torsional moment.

Each leg of the branch connection has a unique set of moments. The notation used here will be:

M_i^{r1} , M_o^{r1} , M_T^{r1} for a run leg

M_i^{r2} , M_o^{r2} , M_T^{r2} for the other run leg

M_i^{b} , M_o^{b} , M_T^{b} for the branch leg

M_i = in plane bending moment (in·lb).

M_o = out of plane bending moment (in·lb).

M_T = Torsional moment(in·lb).

Stresses must be determined for each set of moments.

For a run leg:

$$S^{r1} = \left[\frac{(i'M_i^{r1})^2 + (iM_o^{r1})^2}{(Z^r)^2} + \frac{(M_T^{r1})^2}{(Z^r)^2}\right]^{\frac{1}{2}}$$

Z^r = Run pipe section modulus $(in)^3$.

The stress for the other run leg, S^{r2}, is determined in the same manner.

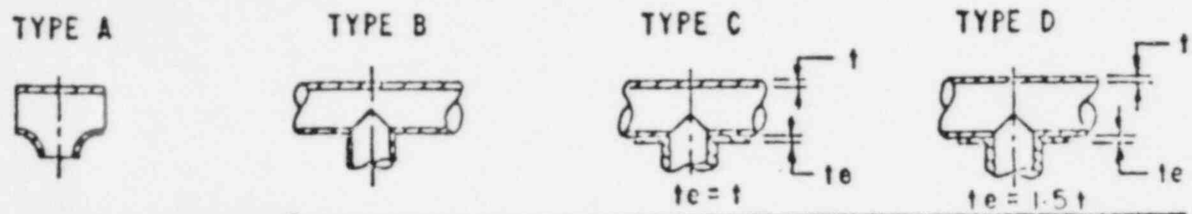
For the branch leg:

$$S^b = \left[\frac{(i'M_i^b)^2 + (iM_o^b)^2}{(Z_b)^2} + \frac{(M_T)^2}{(Z^b)^2}\right]^{\frac{1}{2}}$$

Z_b = Effective section modulus of the branch pipe as determined in the body of this memorandum. $(in)^3$.

Z^b = Nominal section modulus of the branch pipe $(in)^3$.

The maximum stress for the branch connection is the largest of the three stress values determined above.



3" NOMINAL (RUN) SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	·120	1·9542	5·2471	2·6695	2·0646
20					
30					
STD	·216	1·2956	3·4787	1·7698	1·3688
40	·216	1·2956	3·4787	1·7698	1·3688
60					
X STR	·300	1·0230	2·7468	1·3974	1·0808
80	·300	1·0230	2·7468	1·3974	1·0808
100					
120					
140					
160	·437	1·0	2·0763	1·0564	1·0
XX STR	·600	1·0	1·6203	1·0	1·0

4" NOMINAL (RUN) SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	·120	2·3229	6·2373	3·1733	2·4543
20					
30					
STD	·237	1·4496	3·8922	1·9802	1·5315
40	·237	1·4496	3·8922	1·9802	1·5315
60					
X STR	·337	1·1284	3·0298	1·5415	1·1922
80	·337	1·1284	3·0298	1·5415	1·1922
100					
120	·437	1·0	2·5070	1·2755	1·0
140					
160	·531	1·0	2·1669	1·1024	1·0
XX STR	·674	1·0	1·8040	1·0	1·0

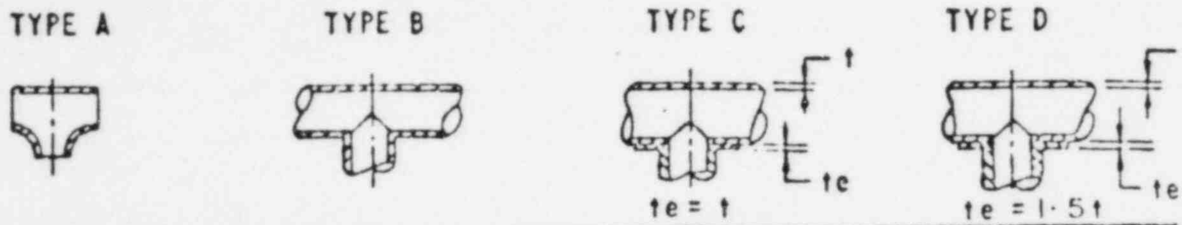
6" NOMINAL (RUN) SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	·134	2·8049	7·5315	3·8317	2·9635
20					
30					
STD	·280	1·6904	4·5389	2·3092	1·7860
40	·280	1·6094	4·5389	2·3092	1·7860
60					
X STR	·432	1·2457	3·3449	1·7018	1·3162
80	·432	1·2457	3·3449	1·7018	1·3162
100					
120	·562	1·0307	2·7675	1·4080	1·0889
140					
160	·718	1·0	2·3100	1·1752	1·0
XX STR	·864	1·0	2·0079	1·0215	1·0

8" NOMINAL (RUN) SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	·148	3·1365	8·4220	4·2847	3·3139
20	·250	2·1936	5·8901	2·9966	2·3176
30	·277	2·0443	5·4892	2·7927	2·1599
STD	·322	1·8425	4·9473	2·5170	1·9467
40	·322	1·8425	4·9473	2·5170	1·9467
60	·406	1·5679	4·2101	2·1419	1·6566
X STR	·500	1·3544	3·6366	1·8502	1·4309
80	·500	1·3544	3·6366	1·8502	1·4309
100	·593	1·1996	3·2211	1·6388	1·2675
120	·718	1·0450	2·8056	1·4275	1·1040
140	·812	1·0	2·5644	1·3047	1·0017
160	·906	1·0	2·3645	1·2030	1·0
XX STR	·875	1·0	2·4268	1·2347	1·0

BASED ON RUN PIPE

ATTACHMENT 1

POWER INDUSTRY GROUP		STRESS ITENSIFICATION FACTORS FOR TEE JOINTS SHEET I	(1)	ORIGINAL
CHECKED	[illegible] 11-10-72		ISSUE	DESCRIPTION
CORRECT	[illegible] 11-10-72			
APPROVED	[illegible]	STANDARD DESIGN GUIDE	STD-MSA-1509-1-	
ISSUE	(2)	(3) (4) (5)		



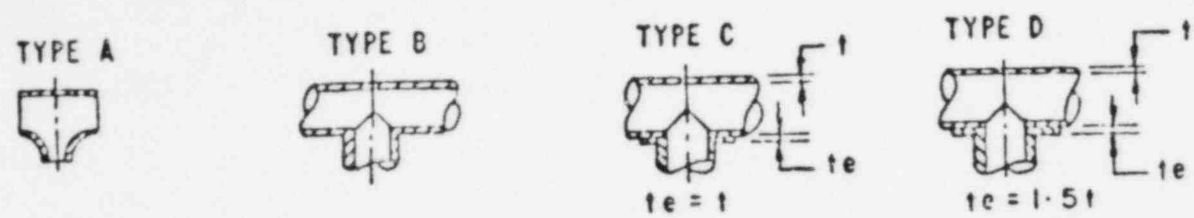
10" NOMINAL RUN SIZE						12" NOMINAL RUN SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D	SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	·165	3·3823	9·0819	4·6205	3·5735	10	·180	3·5797	9·6120	4·8902	3·7821
20	·250	2·5503	6·6491	3·4846	2·6950	20	·250	2·8651	7·6932	3·9140	3·0271
30	·307	2·2164	5·9512	3·0277	2·3417	30	·330	2·3703	6·3658	3·2337	2·5048
STD	·365	1·9676	5·2831	2·6878	2·0788	STD	·375	2·1720	5·8321	2·9672	2·2943
40	·365	1·9676	5·2831	2·6878	2·0788	40	·406	2·0565	5·5218	2·8093	2·1727
60	·500	1·5811	4·2454	2·1599	1·6705	60	·562	1·6417	4·4082	2·2427	1·7345
X STR	·500	1·5811	4·2454	2·1599	1·6705	X STR	·500	1·7803	4·7817	2·4327	1·8315
80	·593	1·4027	3·7664	1·9162	1·4820	80	·687	1·4263	3·8296	1·9484	1·5069
100	·718	1·2248	3·2886	1·6731	1·2940	100	·843	1·2337	3·3125	1·6853	1·3034
120	·843	1·0914	2·9304	1·4909	1·15[illegible]	120	1·000	1·0912	2·9299	1·4906	1·1529
140	1·000	1·0	2·5672	1·3163	1·0180	140	1·125	1·0021	2·6907	1·3689	1·0587
160	1·125	1·0	2·3716	1·2066	1·0	160	1·312	1·0	2·4012	1·2217	1·0
XX STR						XX STR					

14" NOMINAL RUN SIZE						16" NOMINAL RUN SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D	SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	·250	3·0530	8·1975	4·1706	3·2256	10	·250	3·3423	8·9745	4·5658	3·5313
20	·312	2·6260	7·0512	3·5874	2·7745	20	·312	2·8753	7·7219	3·9286	3·0384
30	·375	2·3159	6·2183	3·1636	2·4468	30	·375	2·5373	6·8130	3·4662	2·6808
STD	·375	2·3159	6·2183	3·1636	2·4463	STD	·375	2·5373	6·8130	3·4662	2·6808
40	·437	2·0850	5·5984	2·8482	2·2029	40	·500	2·0833	5·5939	2·8460	2·2011
60	·593	1·6879	4·5321	2·3057	1·7833	60	·656	1·7255	4·6360	2·3586	1·8242
X STR	·500	1·9000	5·1016	2·5955	2·0074	X STR	·500	2·0833	5·5939	2·8460	2·2011
80	·750	1·4323	3·8459	1·9567	1·5133	80	·843	1·4490	3·8907	1·9794	1·5309
100	·937	1·2229	3·2836	1·6706	1·2921	100	1·031	1·2564	3·3736	1·7164	1·3275
120	1·062	1·1176	3·0014	1·5270	1·1810	120	1·218	1·1149	2·9937	1·5231	1·1780
140	1·250	1·0	2·6662	1·3565	1·0491	140	1·437	1·0	2·6549	1·3507	1·0446
160	1·406	1·0	2·4450	1·2439	1·0	160	1·562	1·0	2·4967	1·2703	1·0
XX STR						XX STR					

BASED ON RUN PIPE

ATTACHMENT 1F

POWER INDUSTRY GROUP		STRESS INTENSIFICATION FACTORS FOR TEE JOINTS SHEET 2	(1)	[illegible]
CHECKED	[illegible] 12-20-72		ISSUE	DESCRIPTION
CORRECT	[illegible] 12-20-72			
APPROVED	[illegible]	STANDARD DESIGN GUIDE	STD-MSA-1509-2-	
ISSUE	(2)	(3) (4) (5)		



18" NOMINAL RUN SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	.250	3.6196	9.7191	4.9446	3.8242
20	.312	3.1153	8.3648	4.2557	3.2914
30	.437	2.4767	6.6503	3.3834	2.6168
STD	.375	2.7492	7.3819	3.7556	2.9046
40	.562	2.0346	5.5972	2.8476	2.2024
60	.750	1.7074	4.5846	2.3324	1.8039
X STR	.500	2.2589	6.0653	3.0858	2.3656
80	.937	1.4613	3.9238	1.9963	1.5439
100	1.157	1.2587	3.3797	1.7195	1.3299
120	1.343	1.1312	3.0375	1.5453	1.1952
140	1.562	1.0139	2.7224	1.3850	1.0712
160	1.750	1.0	2.5045	1.2742	1.0
XX STR					

20" NOMINAL RUN SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	.250	3.8864	10.4355	5.3091	4.1061
20	.375	2.9536	7.9307	4.0348	3.1206
30	.500	2.4277	6.5187	3.3165	2.5650
STD	.375	2.9536	7.9307	4.0348	3.1206
40	.593	2.1560	5.7997	2.9507	2.2821
60	.812	1.7384	4.6679	2.3743	1.8367
X STR	.500	2.4277	6.5187	3.3165	2.5650
80	1.031	1.4714	3.9509	2.0100	1.5546
100	1.250	1.2841	3.4479	1.7541	1.3567
120	1.500	1.1270	3.0260	1.5395	1.1907
140	1.750	1.0078	2.7059	1.3767	1.0647
160	1.937	1.0	2.5116	1.2778	1.0
XX STR					

24" NOMINAL RUN SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	.250	4.3949	11.8008	6.0037	4.6434
20	.375	3.3422	8.9741	4.5657	3.5311
30	.562	2.5388	6.8168	3.4681	2.6823
STD	.375	3.3422	8.9741	4.5657	3.5311
40	.687	2.2128	5.9417	3.0229	2.3379
60	.937	1.7876	4.7999	2.4420	1.8887
X STR	.500	2.7493	7.3822	3.7558	2.9048
80	1.218	1.4876	3.9942	2.0321	1.5717
100	1.500	1.2841	3.4479	1.7541	1.3567
120	1.750	1.1501	3.0881	1.5711	1.2151
140	2.062	1.0824	2.9063	1.4786	1.1436
160	2.312	1.0	2.5215	1.2828	1.0
XX STR					

30" NOMINAL RUN SIZE					
SCH	t	TYPE A	TYPE B	TYPE C	TYPE D
10	.312				
STD	.375				
	.438				
60					
X STR	.500	3.21	3.57	4.371	3.382
	.562				
	.625				

BASED ON RUN PIPE

ATTACHMENT 1B

POWER INDUSTRY GROUP		STRESS INTENSIFICATION FACTORS FOR TEE JOINTS SHEET 3	ISSUE	DESCRIPTION
CHECKED	[illegible] 12-20-72		1	[illegible]
CORRECT	[illegible] 12-20-72			
APPROVED	[illegible]	STANDARD DESIGN GUIDE		STD-MSA-1509-3-
ISSUE	2	3	4	5

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516.05.04-NP(3)-013		8

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
4-6-79	JMC 4/6/79	4/6/79

SUBJECT/TITLE: Stress Intensification Factors For "Weldolets"

QA CATEGORY/CODE CLASS

Stress Intensification Factors
Bonney Forge Corporation
Weldolets

Standard Wt			Extra Strong		
Run Size NPS	Branch Size	SIF	Run Size NPS	Branch Size	SIF
2	All	1.52	2	All	1.18
3	↓	1.57	3	↓	1.24
4		1.76	4		1.37
6		2.05	6		1.51
8		2.23	8		1.64
10		2.38	10		1.92
12		2.63	12		2.16
14		2.81	14		2.30
16		3.07	16		2.52
18		3.33	18		2.74
20		3.58	20		2.94
22		3.82	22		3.14
24		4.05	24		3.33
30		4.71	30		3.88
36		5.33	36		4.39

Attachment 7

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	PAGE

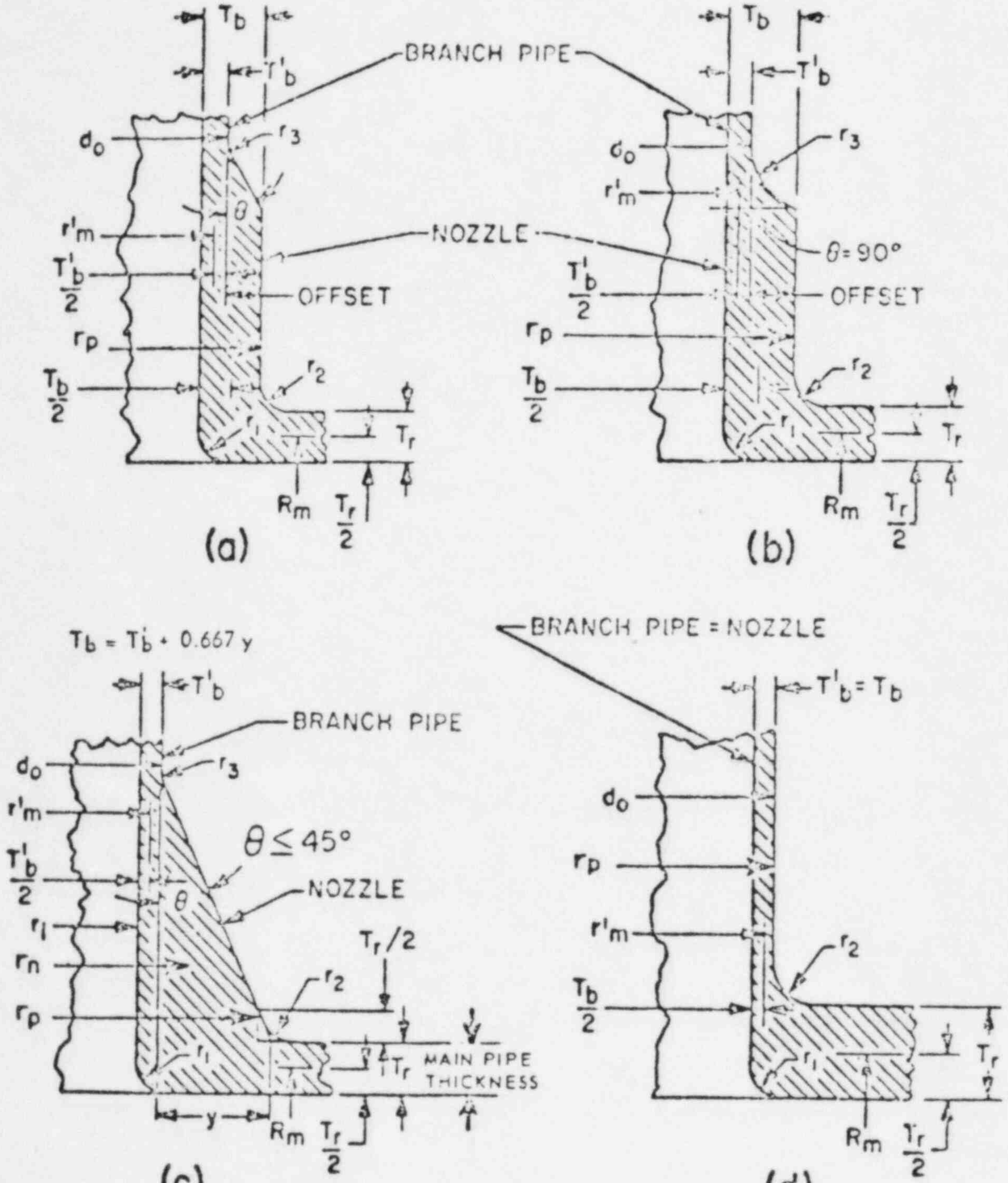
PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

STRESS INTENSIFICATION FACTORS
BONNEY FORGE CORPORATION
LATROLETS

STANDARD WT			EXTRA STRONG		
RUN SIZE NPS	BRANCH SIZE	SIF OUT OF PLANE	RUN SIZE NPS	BRANCH SIZE	SIF OUT OF PLANE
2	ALL	2.14	2	ALL	1.66
3	↓	2.21	3	↓	1.75
4	↓	2.48	4	↓	1.93
6	↓	2.89	6	↓	2.13
8	↓	3.15	8	↓	2.31
10	↓	3.36	10	↓	2.70
12	↓	3.71	12	↓	3.04
14	↓	3.96	14	↓	3.25
16	↓	4.34	16	↓	3.56
18	↓	4.70	18	↓	3.86
20	↓	5.05	20	↓	4.15
22	↓	5.39	22	↓	4.43
24	↓	5.71	24	↓	4.70
30	↓	6.64	30	↓	5.47
36	↓	7.51	36	↓	6.19

ATTACHMENT 2A



ATTACHMENT 3

FIG. D-1 NOZZLE DIMENSIONS

APPENDIX D – Table D-2 (Cont.)

Component	Sketch	Stress Intensification Factor
Branch Connections	See Figure D-1	$i = 1.5 \left(\frac{R_m}{T_r}\right)^{\frac{2}{3}} \left(\frac{r'_m}{R_m}\right)^{\frac{1}{2}} \left(\frac{T'_b}{T_r}\right)\left(\frac{r'_m}{r_p}\right)$ (see Notes 3 and 4)

Notes for Table D-2:

Note 3:

The equation applies only if the following conditions are met:

(a) The reinforcement area requirements of 104.3 are met.

(b) The axis of the branch pipe is normal to the surface of the run pipe wall.

(c) For branch connections in a pipe, the arc distance measured between the centers of adjacent branches along the surface of the run pipe is not less than three times the sum of their inside radii in the longitudinal direction or is not less than two times the sum of their radii along the circumference of the run pipe.

(d) The inside corner radius, r_1 (see Fig. D-1) is between 10 percent and 50 percent of T_r.

(e) The outer radius, r_2, (see Fig. D-1) is not less than the larger of $T_b/2$, $(T_b + y)/2$ [for Fig. D-1 (c)] or $T_r/2$.

(f) The outer radius, r_3, (see Fig. D-1) is not less than the larger of

(1) $0.002\ \theta d_o$

(2) $2 (\sin \theta)^3$ times the offset for the configurations shown in Figs. D-1 (a) and D-1 (b).

(h) $R_m/T_r \leq 50$ and $r'm/Rm \leq 0.5$

Note 4:

The following nomenclature applies to Figure D-1:

r_i = inside radius of branch pipe, in.

r'_m = mean radius of branch pipe, in.

T_b' = nominal thickness of branch pipe, in.

R_m = mean radius of run pipe, in.

T_r = nominal thickness of run pipe, in.

d_o = outside diameter of branch, in.

T_b, θ, r_1, r_2, r_3, r_p and y are defined in Figure D-1

t_r = minimum required thickness of run pipe, calculated as a plain cylinder

ATTACHMENT 3A

ATTACHMENT 4

MAXIMUM SIZE OF BRANCH FOR WHICH (SIF) NEED NOT BE APPLIED TO THE RUN

* WHERE SPECIFIC SCHEDULES ARE LISTED, THINNER PIPES OF THAT SIZE SHALL NOT BE USED

RUN PIPE O.D. (IN)	RUN PIPE TH'K / SCHED (IN)	BRANCH PIPE MEAN DIA. (MAX), (IN)	MAX BRANCH (NPS)* (IN)
36.0	0.500 XS	4.108	4" SCH 120 3" & LESS
36.0	0.375 STD	3.395	3" & LESS
30.0	0.500 XS	3.862	4" XXS 3" & LESS
30.0	0.375 STD	3.193	3" SCH 160 2½" & LESS
24.0	0.500 XS	3.580	3" & LESS
24.0	0.375 STD	2.961	2½" & LESS
18.0	0.500 XS	3.245	3" SCH 80 2½" & LESS
18.0	0.375 STD	2.685	2½" STD 2" & LESS
16.0	0.500 XS	3.117	3" SCH 160 2½" & LESS
16.0	0.375 STD	2.580	2½" SCH 160 2" & LESS

RUN PIPE O.D. (IN)	RUN PIPE TH'K / SCHED (IN)	BRANCH PIPE MEAN DIA. (MAX), (IN)	MAX BRANCH (NPS)* (IN)
14.0	0.500 XS	2.976	3" XXS 2½" & LESS
14.0	0.375 STD	2.465	2½" XXS 2" & LESS
12.750	0.500 XS	2.882	2½" & LESS
12.750	0.375 STD	2.387	2½" XXS 2" & LESS
10.750	0.500 XS	2.715	2½" STD 2" & LESS
10.750	0.365 STD	2.211	2" SCH 80S 1½" & LESS
8.625	0.500 XS	2.513	2" & LESS
8.625	0.322 STD	1.888	1½" & LESS
6.625	0.432 XS	2.082	2" SCH 160 1½" & LESS
6.625	0.280 STD	1.572	1½" XXS 1¼" & LESS
4.500	0.237 STD	1.232	1" & LESS

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.

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PAGE

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SUBJECT/TITLE EMD-79-11 ATTACHMENT 4

REVIEWER/CHECKER/DATE [illegible]

INDEPENDENT REVIEWER/DATE

QA CATEGORY/CODE CLASS B31.1

INTEROFFICE MEMORANDUM

SUBJECT PIPE STRESS SPECIAL PROGRAM

J O OR W O NO 12365.08/12966.41 12690.89/12846.22 /13359

DATE May 25, 1979

FROM DTKing

TO Task Force Distribution List

CC

EMD 79-15 provides general procedure for the stress analysis of B 31.1.0 branch piping. EMD 79-11 provides technical information relating to the use of stress intensification factors and stresses for reduced outlet branch connections (B 31.1).

This memorandum is intended to provide clarification with respect to the applicability of EMD 79-15 and 79-11. EMD 79-15 shall be used to identify branch line which must be included in the analysis of a piping run. EMD 79-11 shall be applied only to those branch lines which have been identified by EMD 79-15.

Project Engineers are directed to incorporate this policy into respective Project Procedures for evaluation of dynamic pipe stress analysis.

DTKing

D. T. King

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No.	Title	Issue Date
EMD-79-19	USAS B31.1 Stress Computations	5/14/79
EMD-79-20	Conversion of PSTRESS/SHOCK Data to Nupipe Data	5/22/79