

TABLE NO. I
THRUST BLOCK AREA REQUIRED

0-50 PSI Test Pressure THRUST AREA Req'd Ft. ²						51-100 PSI Test Pressure THRUST AREA Req'd Ft. ²						101-150 PSI Test Pressure THRUST AREA Req'd Ft. ²					
NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND	NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND	NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND
4	1.0	1.0	1.0	1.0	1.0	4	1.0	2.0	1.0	1.0	1.0	4	2.0	2.0	1.0	1.0	1.0
6	1.0	2.0	1.0	1.0	1.0	6	2.0	3.0	2.0	1.0	1.0	6	3.0	4.0	2.0	1.0	1.0
8	2.0	3.0	1.0	1.0	1.0	8	3.0	5.0	3.0	2.0	1.0	8	5.0	7.0	4.0	2.0	1.0
10	3.0	3.0	2.0	1.0	1.0	10	5.0	7.0	4.0	2.0	1.0	10	8.0	11.0	6.0	3.0	2.0
12	4.0	5.0	3.0	2.0	1.0	12	7.0	10.0	5.0	3.0	2.0	12	10.0	15.0	8.0	4.0	2.0
14	5.0	7.0	4.0	2.0	1.0	14	9.0	13.0	7.0	4.0	2.0	14	14.0	22.0	11.0	6.0	3.0
16	6.0	7.0	5.0	3.0	1.0	16	12.0	17.0	9.0	5.0	3.0	16	18.0	25.0	14.0	7.0	4.0
18	8.0	11.0	6.0	3.0	2.0	18	15.0	21.0	12.0	6.0	3.0	18	23.0	32.0	17.0	9.0	5.0
20	9.0	13.0	7.0	4.0	2.0	20	19.0	26.0	14.0	7.0	4.0	20	28.0	39.0	21.0	11.0	6.0
24	13.0	19.0	10.0	5.0	3.0	24	26.0	37.0	20.0	10.0	5.0	24	39.0	56.0	30.0	15.0	8.0
30	20.0	29.0	16.0	8.0	4.0	30	40.0	57.0	31.0	16.0	8.0	30	61.0	86.0	46.0	24.0	12.0
36	29.0	41.0	22.0	12.0	6.0	36	58.0	82.0	44.0	23.0	12.0	36	87.0	122.0	66.0	34.0	17.0
42	39.0	55.0	30.0	15.0	7.0	42	78.0	110.0	60.0	31.0	15.0	42	117.0	165.0	90.0	46.0	23.0
48	51.0	72.0	39.0	20.0	10.0	48	102.0	144.0	78.0	40.0	20.0	48	152.0	215.0	117.0	60.0	30.0
54	64.0	91.0	49.0	25.0	13.0	54	128.0	181.0	98.0	50.0	25.0	54	194.0	272.0	147.0	75.0	38.0

- NOTES**
- WHERE A HORIZONTAL BEND IS MADE, THE PIPING SHALL BE RESTRAINED BY MEANS OF A THRUST BLOCK AS DETAILED ON THIS SHEET. WHERE VERTICAL OFFSETS ARE MADE, THE TOP BEND SHALL BE RESTRAINED BY RESTRAINING RODS AND STRAPS, CONCRETE THRUST ANCHOR BLOCKS AND RESTRAINING RODS, OR A COMBINATION OF BOTH. THE BOTTOM BENDS SHALL BE RESTRAINED BY THRUST BLOCKS AS DETAILED.
 - "A", "B" AND "D" DIMENSIONS SHALL BE AS LARGE AS POSSIBLE WITHOUT INTERFERING WITH THE MECHANICAL JOINTS OR THE M, J, BOLTS.
 - "C" DIMENSIONS SHALL BE LARGE ENOUGH TO MAKE ANGLE θ EQUAL TO OR LARGER THAN 45°.
 - ANGLE θ SHALL BE EQUAL TO OR LARGER THAN 45°.
 - "B" & "D" DIMENSIONS SHALL PROVIDE REQUIRED BLOCKING AREA AS LISTED IN TABLE I. REFER TO PIPE SCHEDULE IN THE SPECIFICATIONS FOR THE PRESSURE RATING OF THE PIPING SYSTEMS.
 - HARD WOOD BLOCKING MAY BE USED IN LIEU OF CONCRETE BUTTRESSES FOR TEES, DEAD ENDS, 90° BENDS AND 45° BENDS HAVING A SIZE OF 4 IN., 6 IN. AND 8 IN. AND FOR 11-1/4° AND 22-1/2° BENDS HAVING A SIZE OF 4 IN., 6 IN., 8 IN. AND 12 IN. PROVIDED THE AREA OF THE BLOCKING IN CONTACT WITH THE UNDISTURBED SOIL IS AT LEAST EQUAL TO THE AREA OF THE CONCRETE SHOWN IN TABLE I. REFER TO PIPE SCHEDULE IN THE SPECIFICATIONS FOR THE PRESSURE RATING OF THE PIPING SYSTEMS.
 - CONCRETE SHALL BEAR ON ONE COMPLETE QUADRANT OF PIPE AS A MINIMUM, SEE DETAIL ABOVE.
 - WHERE THRUST BLOCKS ARE NOT POSSIBLE BECAUSE OF POOR SOIL CONDITIONS OR LACK OF ROOM, STRAPPING SHALL BE PERMITTED. THE CONTRACTOR SHALL SUBMIT, TO THE ENGINEER FOR REVIEW, A LIST OF RESTRAINT MATERIAL, DETAILS OF THE RESTRAINT AND METHODS OF CONSTRUCTION, AND SIZES OF ALL RESTRAINT MEMBERS HE DESIRES TO USE FOR THRUST ANCHOR BLOCKS, RESTRAINING RODS AND STRAPS. REFER TO PIPE SCHEDULE IN THE SPECIFICATIONS FOR THE PRESSURE RATING OF THE PIPING SYSTEMS.
 - THE THRUST BLOCK AREAS SHOWN IN TABLE I ARE CALCULATED USING A SOIL BEARING CAPACITY OF 2000 PSF. IF GREATER SOIL BEARING CAPACITY IS AVAILABLE, THE CONTRACTOR MAY, AFTER REVIEW BY THE ENGINEER, REDUCE THE THRUST BLOCK AREAS SHOWN ON TABLE I. THE THRUST BLOCK AREA SHALL BE INCREASED IF THE SOIL IS NOT CAPABLE OF PROVIDING 2000 PSF SOIL BEARING CAPACITY.
 - THE CONCRETE FOR BUTTRESSES SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 2500 PSI.
 - IF THE CONTRACTOR DESIRES TO USE ALTERNATE METHODS OF RESTRAINT, HE SHALL SUBMIT A RESTRAINT SCHEDULE TO THE ENGINEER FOR REVIEW, DETAILING THE SYSTEM THAT HE PROPOSES TO USE.
 - RESTRAINT RODS FOR BOTH INTERIOR AND EXTERIOR PIPING SYSTEMS SHALL BE INSTALLED IN ACCORDANCE WITH THE NUMBER AND SIZE LISTED IN TABLE II AND/OR TABLE III. THE NUMBER AND SIZE OF RESTRAINING RODS IN TABLE II AND/OR TABLE III SHALL BE ANCHORED TO PROVIDE A RIGID PIPING SYSTEM. THE CONTRACTOR SHALL SUBMIT DETAILS OF THE RESTRAINT SYSTEM TO THE ENGINEER FOR REVIEW. ALL RESTRAINING RODS SHALL BE EQUALLY SPACED AROUND THE CIRCUMFERENCE OF THE PIPE. INTERIOR RESTRAINING RODS SHALL BE PAINTED THE SAME PAINTING SYSTEM SPECIFIED FOR THE PIPING SYSTEM. EXTERIOR RESTRAINING RODS AND MISCELLANEOUS STEEL MATERIALS SHALL BE COATED A BITUMASTIC PAINT, KOPPERS NO. 503, MOBILE, OR EQUAL.
 - THE CONTRACTOR SHALL SIZE ALL STRAPS, BOLTS, AND WASHERS TO BE COMPATIBLE WITH THE STRENGTH OF THE RESTRAINING RODS AND THE DETAILS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW.
 - THE CONTRACTOR SHALL REFER TO THE LATEST EDITION OF "A GUIDE FOR THE INSTALLATION OF DUCTILE IRON PIPE" PUBLISHED BY THE CAST IRON PIPE RESEARCH ASSOCIATION FOR DESIGN AND INSTALLATION OF RESTRAINT SYSTEMS.

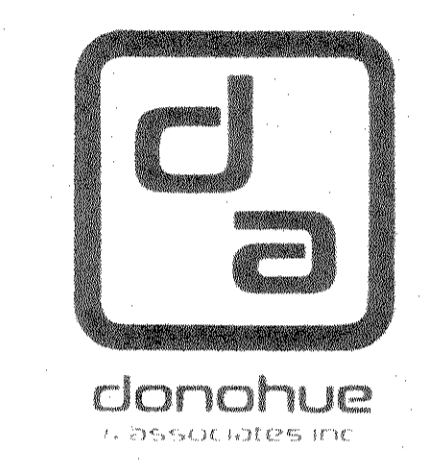
TABLE NO. II
RESTRAINING ROD REQUIREMENTS FOR MECHANICAL JOINT PIPING SYSTEMS

0-50 PSI Test Pressure Number & Size of Restraining Rods						51-100 PSI Test Pressure Number & Size of Restraining Rods						101-150 PSI Test Pressure Number & Size of Restraining Rods					
NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND	NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND	NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND
4	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	4	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	4	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
6	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	6	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	6	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
8	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	8	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	8	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
10	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	10	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	10	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
12	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	12	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	12	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
14	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	14	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	14	(5)3/4"	(5)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
16	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	16	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	16	(6)3/4"	(6)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
18	(3)3/4"	(3)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	18	(6)3/4"	(6)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	18	(3)3/4"	(8)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
20	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	20	(6)3/4"	(6)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	20	(10)3/4"	(10)3/4"	(3)3/4"	(2)3/4"	(2)3/4"
24	(4)3/4"	(4)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	24	(8)3/4"	(8)3/4"	(3)3/4"	(2)3/4"	(2)3/4"	24	(12)3/4"	(12)3/4"	(4)3/4"	(2)3/4"	(2)3/4"
30	(4) 1"	(4) 1"	(2) 1"	(2) 1"	(2) 1"	30	(7) 1"	(7) 1"	(2) 1"	(2) 1"	(2) 1"	30	(10) 1"	(10) 1"	(3) 1"	(2) 1"	(2) 1"
36	(5) 1"	(5) 1"	(2) 1"	(2) 1"	(2) 1"	36	(10) 1"	(10) 1"	(3) 1"	(2) 1"	(2) 1"	36	(15) 1"	(15) 1"	(5) 1"	(2) 1"	(2) 1"
42	(4)1-1/4"	(4)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	42	(11)1-1/4"	(11)1-1/4"	(3)1-1/4"	(2)1-1/4"	(2)1-1/4"	42	(12)1-1/4"	(12)1-1/4"	(4)1-1/4"	(2)1-1/4"	(2)1-1/4"
48	(6)1-1/4"	(6)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	48	(11)1-1/4"	(11)1-1/4"	(3)1-1/4"	(2)1-1/4"	(2)1-1/4"	48	(16)1-1/4"	(16)1-1/4"	(5)1-1/4"	(2)1-1/4"	(2)1-1/4"
54	(7)1-1/4"	(7)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	54	(14)1-1/4"	(14)1-1/4"	(4)1-1/4"	(2)1-1/4"	(2)1-1/4"	54	(20)1-1/4"	(20)1-1/4"	(6)1-1/4"	(2)1-1/4"	(2)1-1/4"

TABLE NO. III
RESTRAINING ROD REQUIREMENTS FOR FLANGED PIPING SYSTEMS

0-50 PSI Test Pressure Number & Size of Restraining Rods						51-100 PSI Test Pressure Number & Size of Restraining Rods						101-150 PSI Test Pressure Number & Size of Restraining Rods					
NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND	NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND	NOM. PIPE DIA.	DEAD END	90° BEND	45° BEND	22-1/2° BEND	11-1/4° BEND
4	(2)5/8"	(2)5/8"	(2)5/8"	(2)5/8"	(2)5/8"	4	(2)5/8"	(2)5/8"	(2)5/8"	(2)5/8"	(2)5/8"	4	(2)5/8"	(2)5/8"	(2)5/8"	(2)5/8"	(2)5/8"
6	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	6	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	6	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
8	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	8	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	8	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"	(2)3/4"
10	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	10	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	10	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"
12	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	12	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	12	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"	(2)7/8"
14	(2) 1"	(2) 1"	(2) 1"	(2) 1"	(2) 1"	14	(2) 1"	(2) 1"	(2) 1"	(2) 1"	(2) 1"	14	(2) 1"	(2) 1"	(2) 1"	(2) 1"	(2) 1"
16	(2) 1"	(2) 1"	(2) 1"	(2) 1"	(2) 1"	16	(2) 1"	(2) 1"	(2) 1"	(2) 1"	(2) 1"	16	(2) 1"	(2) 1"	(2) 1"	(2) 1"	(2) 1"
18	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	18	(4)1-1/8"	(4)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	18	(4)1-1/8"	(4)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"
20	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	20	(4)1-1/8"	(4)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"	20	(4)1-1/8"	(4)1-1/8"	(2)1-1/8"	(2)1-1/8"	(2)1-1/8"
24	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	24	(4)1-1/4"	(4)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	24	(5)1-1/4"	(5)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"
30	(3)1-1/4"	(3)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	30	(5)1-1/4"	(5)1-1/4"	(2)1-1/4"	(2)1-1/4"	(2)1-1/4"	30	(7)1-1/4"	(7)1-1/4"	(3)1-1/4"	(2)1-1/4"	(2)1-1/4"
36	(3)1-1/2"	(3)1-1/2"	(2)1-1/2"	(2)1-1/2"	(2)1-1/2"	36	(5)1-1/2"	(5)1-1/2"	(2)1-1/2"	(2)1-1/2"	(2)1-1/2"	36	(7)1-1/2"	(7)1-1/2"	(3)1-1/2"	(2)1-1/2"	(2)1-1/2"
42	(4)1-1/2"	(4)1-1/2"	(2)1-1/2"	(2)1-1/2"	(2)1-1/2"	42	(6)1-1/2"	(6)1-1/2"	(3)1-1/2"	(2)1-1/2"	(2)1-1/2"	42	(10)1-1/2"	(10)1-1/2"	(4)1-1/2"	(2)1-1/2"	(2)1-1/2"
48	(4)1-1/2"	(4)1-1/2"	(2)1-1/2"	(2)1-1/2"	(2)1-1/2"	48	(8)1-1/2"	(8)1-1/2"	(3)1-1/2"	(2)1-1/2"	(2)1-1/2"	48	(12)1-1/2"	(12)1-1/2"	(4)1-1/2"	(2)1-1/2"	(2)1-1/2"
54	(6)1-1/2"	(6)1-1/2"	(3)1-1/2"	(2)1-1/2"	(2)1-1/2"	54	(16)1-1/2"	(16)1-1/2"	(6)1-1/2"	(2)1-1/2"	(2)1-1/2"	54	(16)1-1/2"	(16)1-1/2"	(6)1-1/2"	(2)1-1/2"	(2)1-1/2"

DESIGNER	CSH	DRAWN BY	CTR
CHECKED		APPROVED	
DATE	Aug, 1980		
SCALE	NONE		



WATER SYSTEM IMPROVEMENTS
 THRUST BLOCKS & RESTRAINT DETAILS
 TOMAHAWK, WISCONSIN

PROJECT NO
10410.200

FILE NO
SK-10600

SHEET NO
11 OF 11