SNOWMAN'S NOTES

Insulator's Notes

FEBRUARY 1, 2018

SNOWMAN
Member of Local 110

CONTENTS

BASICS

Line Numbering

1 2 3 4 5 6

Colors shall follow a modified rainbow: Red, blue, green, light blue, purple and pink, and repeat as required.

Abbreviations

BD	Blow Down
CL	Center Line — - — - — - — -
DPI	Delta Pressure Indicator
DPSH	Delta Pressure Suction Head
FI	Flow Indicator
FOF	Flush on Face
FR	Flow Recorder
FRC	Flow recorder Controller
FW	Field Weld
ID	Inside Diameter
ILS	
LA	Level Alarm
LC	Level Control
LCV	Level Control Valve
LG	Level Gauge
LRC	Level Recording Controller
OC	Outer Circumference
OD	Outside Diameter
OLS	
PC	Pressure Controller
PI	Pressure Indicator
PM	Process Module (Piping Mod)
PSV	Pressure Safety Valve
SB	Stick Built
T	Steam Trap
TCV	Temperature Control Valve
TI	Temperature Indicator
TIC	Temperature Indicator Controller
TOC	Top of Concrete
TOS	Top of Steel
TRC	Temperature Recorder Controller

Basic Tool List

- Nippers 6” or 8” End-cutting
- Tape Measure: 12’X3/4”
- Scissors
- Knives:
    - Duct wrap
    - FIG Pipe covering
    - Rubber work
- Sharpening Stone
- Framing Square
- Hand Saw
- Docking Saw for Cal Sil
- Keyhole Saw
- Cotter Key Extractor
- Trowels:
    - Painting
    - Bullnose
    - Flat
- Awl
- Hammer
- 4’ Straight Edge
- Tin Snips
    - Right
    - Left
    - Straight
- Dividers
    - Large Set
    - 24” pair
    - 6” or 8” pair
- Tool Pouch or Bag
- Diameter Tape
- Chalk Line
- Hand Notchers

Fractions and Decimals

Fraction	Decimal	Fraction2	Decimal3
1/32	0.03125	17/32	0.53125
1/16	0.0625	9/16	0.5625
3/32	0.09375	19/32	0.59375
1/8	0.125	5/8	0.625
5/32	0.15625	21/32	0.65625
3/16	0.1875	11/16	0.6875
7/32	0.21875	23/32	0.71875
1/4	0.25	3/4	0.75
9/32	0.28125	25/32	0.78125
5/16	0.3125	13/16	0.8125
11/32	0.34375	27/32	0.84375
3/8	0.375	7/8	0.875
13/32	0.40625	29/32	0.90625
7/16	0.4375	15/16	0.9375
15/32	0.46875	31/32	0.96875
1/2	0.5	1	1

Flanges

Pipe Size	150 #	300 #	400 #	600 #	900 #	1500 #
2	6	6.5	6.5	6.5	8.5	8.5
3	7.5	8.25	8.25	8.25	9.5	10.5
4	9	10	10	10.75	11.5	12.25
5	10	11	11	13	13.75	14.75
6	11	12.5	12.5	14	15	15.5
8	13.5	15	15.5	16.5	18.5	19
10	16	17.5	17.5	20	21.5	23
12	19	20.5	20.5	22	24	26.5
14	21	23	23	23.75	25.25	29.5
16	23.5	25.5	25.5	27	27.75	32.5
18	25	28	28	29.25	31	36
20	27.5	30.5	30.5	32	33.75	38.75
24	32	36	36	37	41	46

Circle Weights

Number of Divisions	Weight Number	Number of Divisions	Weight Number
2	2.000	19	0.330
3	1.732	20	0.296
4	1.414	21	0.284
5	1.176	22	0.273
6	1.000	23	0.261
7	0.866	24	0.250
8	0.765	25	0.246
9	0.684	26	0.237
10	0.618	27	0.234
11	0.562	28	0.218
12	0.518	29	0.217
13	0.478	30	0.214
14	0.444	31	0.206
15	0.416	32	0.199
16	0.390	33	0.194
17	0.370	34	0.186
18	0.347	35	0.181
		36	0.179

Metal Bands

Pipe Size	Thickness	Diameter	Me
1/2	1	3	
3/4	1	3	
1	1	3 1/2	
1 1/4	1	3 1/2	
1/2	1 1/2	4	
3/4	1 1/2	4	
1 1/2	1	4	
1	1 1/2	4 1/2	
1 1/4	1 1/2	4 1/2	
2	1	4 1/2	
1/2	2	5	
3/4	2	5	
1 1/2	1 1/2	5	
1	2	5 1/2	
1 1/4	2	5 1/2	
2	1 1/2	5 1/2	
2 1/2	1	5 1/2	
3	1	5 1/2	
3/4	2 1/2	6 5/8	
1	2 1/2	6 5/8	
1 1/4	2 1/2	6 5/8	
1 1/2	2	6 5/8	
2	2	6 5/8	
2 1/2	1 1/2	6 5/8	
3	1 1/2	6 5/8	
3 1/2	1	6 5/8	
4	1	6 5/8	
3/4	3	6 5/8	
1	3	7 5/8	
1 1/4	3	7 5/8	
1 1/2	2 1/2	7 5/8	
2	2 1/2	7 5/8	

Pipe Size	Thickness	Diameter	Me
2 1/2	2	7 5/8	
3 / 10 7/8	2 / 19	7 5/8 / 1	
3 1/2	1 1/2	7 5/8	
4 / 12 3/8	1 1/2 / 20	7 5/8 / 1	
4 1/2	1	7 5/8	
5 / 14	1 / 22	7 5/8 / 1	
1 1/2	3	8 3/4	
2 / 14	3 / 22	8 3/4 / 1	
2 1/2	2 1/2	8 3/4	
3 / 16	2 1/2 / 24	8 3/4 / 1 1/2	
3 1/2	2	8 3/4	
4 / 17 5/8	2 / 25	8 3/4 / 1 1/2	
4 1/2	1 1/2	8 3/4	
5 / 17 5/8	1 1/2 / 25	8 3/4 / 1 1/2	
6	1	8 3/4	
1 1/2 / 19 1/8	3 1/2 / 27	9 3/4 / 1 1/2	
2	3 1/2	9 3/4	
2 1/2 / 19 1/8	3 / 27	9 3/4 / 1 1/2	
3	3	9 3/4	
3 1/2 / 22 3/4	2 1/2 / 30	9 3/4 / 1 1/2	
4	2 1/2	9 3/4	
4 1/2 / 22 3/4	2 / 30	9 3/4 / 1 1/2	
5	2	9 3/4	
6 / 22 3/4	1 1/2 / 30	9 3/4 / 1 1/2	
1 1/2	4	10 3/4	
2 / 22 3/4	4 / 30	10 3/4 / 1 1/2	
2 1/2	3 1/2	10 3/4	
3 / 22 3/4	3 1/2 / 33	10 3/4 / 1 1/2	
3 1/2	3	10 3/4	
4 / 25 7/8	3 / 33	10 3/4 / 2	
4 1/2	2 1/2	10 3/4	
5 / 25 7/8	2 1/2 / 33	10 3/4 / 2	
6	2	10 3/4	

Pipe Size	Thickness	Diameter	Metal Length	Band Length	Lap
7	1 1/2	10 3/4	36 1/8	43	2
2 1/2	4	11 3/4	39 1/4	46	2
3	4	11 3/4	39 1/4	46	2
3 1/2	3 1/2	11 3/4	39 1/4	46	2
4	3 1/2	11 3/4	39 1/4	46	2
4 1/2	3	11 3/4	39 1/4	46	2
5	3	11 3/4	39 1/4	46	2
6	2 1/2	11 3/4	39 1/4	46	2
7	2	11 3/4	39 1/4	46	2
8	1 1/2	11 3/4	39 1/4	46	2
3 1/2	4	12 3/4	42 1/2	50	2
4	4	12 3/4	42 1/2	50	2
4 1/2	3 1/2	12 3/4	42 1/2	50	2
5	1/2	12 3/4	42 1/2	50	2
6	3	12 3/4	42 1/2	50	2
7	2 1/2	12 3/4	42 1/2	50	2
8	2	12 3/4	42 1/2	50	2
9	1 1/2	12 3/4	42 1/2	50	2
4 1/2	4	14	47 3/8	53	3
5	4	14	47 3/8	53	3
6	3 1/2	14	47 3/8	53	3
7	3	14	47 3/8	53	3
8	2 1/2	14	47 3/8	53	3
9	2	14	47 3/8	53	3
10	1 1/2	14	47 3/8	53	3
6	4	15 1/8	50 7/8	57	3
7	3 1/2	15 1/8	50 7/8	57	3
8	3	15 1/8	50 7/8	57	3
9	2 1/2	15 1/8	50 7/8	57	3
10	2	15 1/8	50 7/8	57	3
11	1 1/2	15 1/8	50 7/8	57	3
6	4 1/2	16 1/8	54	60	3
7	4	16 1/8	54	60	3

90-Degree Elbows

90 Degree Elbows					
Iron Pipe Size	Insulation Thickness				
	1	1 1/2	2	2 1/2	3
1/2	2	5	8	12	23
3/4	2	5	9	12	23
1	3	6	11	12	23
1 1/4	3	9	11	18	23
1 1/2	4	9	18	23	15
2	7	10	18	20	24
2 1/2	13	16	20	24	25
3	14	19	22	24	25
3 1/2	17	21	27	30	33
4	17	21	27	30	33
4 1/2	28	27	30	38	31
5	28	29	36	38	39
6	32	35	37	39	44
7	35	37	39	44	45
8	41	42	43	47	49
9	42	43	47	49	52
10	46	50	51	55	54
11	50	51	52	56	-
12	48	55	56	-	-

Jacketing and 45-degree elbows

Jacketing and 45 Degree Elbows					
Iron Pipe Size	Insulation Thickness				
	1	1 1/2	2	2 1/2	3
1/2	1	3	5	7	8
3/4	1	3	5	7	8
1	2	4	6	7	8
1 1/4	2	5	6	7	8
1 1/2	3	5	7	8	9
2	4	6	7	8	9
2 1/2	5	7	8	9	10
3	6	7	8	9	10
3 1/2	7	8	9	10	11
4	7	8	9	10	11
4 1/2	8	9	10	11	12
5	8	9	10	11	12
6	9	10	11	12	13
7	10	11	12	13	14
8	11	12	13	14	15
9	12	13	14	15	16
10	13	14	15	16	17
11	14	15	16	17	18
12	15	16	17	18	19
14	16	17	18	19	20
15	17	18	19	20	21
16	18	19	20	21	22
17	19	20	21	22	-
18	20	21	22	-	-
19	21	22	-	-	-
20	22	-	-	-	-

Flange Sizes

Iron Pipe Size	1/2"	OCF	1"	11/2"	2"	21/2"	3"	3/12"	4"	5"	51/2"	6"
3/8"	#2		#7	#9								
1/2"	3		7	10	#12	#15	#17	#18	19#			
3/4"	4	5	7	10	12	15	17	18	19			
1"	5		9	11	13	15	17	18	19			
11/4"	6	7	9	12	13	15	17	18	19			
11/2"	7		10	12	15	17	18	19	20			
2"	9		11	13	15	17	18	19	20	#22	#23	#23
21/2"	10		12	15	17	18	19	20	21	22	23	24
3"	11		13	15	17	18	19	20	21	23	24	25
31/2"	12		15	17	18	19	20	21	22	23	24	25
4"	13		15	17	18	19	20	21	22	24	25	26
5"	15		17	18	19	20	21	22	23	25	26	27
6"	17		18	19	20	21	22	23	24	26	27	28
8"	19		20	21	22	23	24	25	26	26	29	30
10"			22	23	24	25	26	27	28	30	31	32
12"			24	25	26	27	28	29	30	32	34	34
14"			25	26	27	28	29	30	31	33	34	35
16"			27	28	29	30	31	32	33	35	36	37
18"			29	30	31	32	33	34	35	37	38	39
20"			31	32	33	34	35	36	37	39	40	41
22"			33	34	35	36	37	38	39	41	42	43
24"			35	36	37	38	39	40	41	43	44	45

Copper Tube Table

Copper Tube Table

Copper Tubing Size	Actual OD	1/2"	OCF	1"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	5"	5 1/2"	6"
3/8"	1/2"			#5	#9	#11	#13	#15					
1/2"	5/8"	2	3	7	9	11	13	15					
3/4"	7/8"	3	3	7	10	12	15	17	18	#19			
1"	1 1/8"	4	5	7	10	12	15	17	18	19			
1 1/4"	1 3/8"	5	5	9	11	13	15	17	18	19			
1 1/2"	1 5/8"	6	7	9	12	13	15	17	18	19			
2"	2 1/8"	8	9	10	12	15	17	18	19	20	#22	#23	#23
2 1/2"	2 5/8"	9	10	11	13	15	17	18	19	20	22	23	24
3"	3 1/8"	10	11	12	15	17	18	19	20	21	23	24	25
3 1/2"	3 5/8"	11	11	13	15	17	18	19	20	21	23	24	25
4"	4 1/8"	12	13	15	17	18	19	20	21	22	24	25	26
5"	5 1/8"	14	15	17	18	19	20	21	22	23	25	26	27
6"	6 1/8"	16	17	18	19	20	21	22	23	24	26	27	28

90 Degree Aluminum ELL-JACS

90 ° Aluminum ELL-JACS

Iron Pipe Size	Insulation Thickness						
mm	25	38	51	64	76	89	102
inch	1	1.5	2	2.5	3	3.5	4
0.5	2	5	8	12	23	15	25
0.75	2	5	8	12	23	15	25
1	3	6	11	12	23	15	25
1.25	3	9	11	18	23	15	25
1.5	4	9	18	23	15	25	26
2	7	10	18	20	24	25	26
2.5	13	16	20	24	25	26	31
3	14	19	22	24	25	26	31
3.5	17	21	27	30	33	31	34
4	17	21	27	30	33	31	34
4.5	28	27	30	33	31	34	40
5	28	29	36	38	39	34	40
6	32	35	37	39	44	45	57
7	35	37	39	44	45	57	52
8	41	42	43	47	49	52	53
9	42	43	47	49	52	53	GORE
10	46	40	51	55	54	57	58
11	50	51	55	56	57	58	GORE
12	48	55	56	57	58	60	62
14	GORE	GORE	57	58	60	62	61
15	GORE	GORE	GORE	60	62	GORE	GORE
16	GORE	GORE	60	62	61	GORE	GORE
17	GORE	GORE	GORE	61	GORE		
18	GORE	GORE	61	GORE			

45-Degree Aluminum ELL-JACS

Iron Pipe Size	Insulation Thickness						
mm	25	38	51	64	76	89	102
inch	1	1.5	2	2.5	3	3.25	4
0.5	1	3	5	7	8	9	10
0.75	1	3	5	7	8	9	10
1	2	4	6	7	8	9	10
1.25	2	5	6	7	8	9	10
1.5	3	5	7	8	9	10	11
2	4	6	7	8	9	10	11
2.5	5	7	8	9	10	11	12
3	6	7	8	9	10	11	12
3.5	7	8	9	10	11	12	13
4	7	8	9	10	11	12	13
4.5	8	9	10	11	12	13	14
5	8	9	10	11	12	13	14
6	9	10	11	12	13	14	15
7	10	11	12	13	14	15	16
8	11	12	13	14	15	16	17
9	12	13	14	15	16	17	57
10	13	14	15	16	17	57	58
11	14	15	16	17	57	58	60
12	15	16	17	57	58	60	21
14	16	17	57	58	60	21	61
15	17	57	58	60	21	61	GORE
16	57	58	60	21	61	GORE	GORE
17	58	60	21	61	GORE	GORE	GORE
18	60	21	61	GORE	GORE	GORE	GORE
19	21	61	GORE	GORE	GORE	GORE	GORE
20	21	GORE	GORE	GORE	GORE	GORE	GORE

Copper Pipe Jacketing

Copper Pipe Call out size in "	Actual Size in inches	
3/8		
5/8		
7/8	1/2	IPS
1 1/8	3/4	IPS
1 3/8	1	IPS
1 5/8	1 1/4	IPS
1 7/8		
& up	Equal to call out	

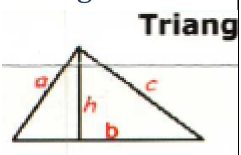
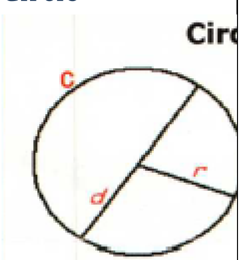
Iron Jacketing

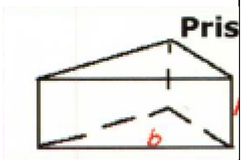
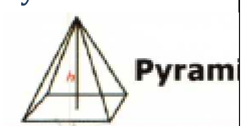
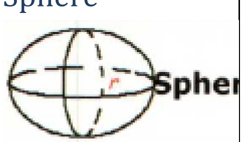
Call out size in "	Iron Actual Size in inches
3/8	5/8
1/2	7/8
3/4	1 1/8
1	1 3/8
1 1/4	1 5/8
1 1/2	1 15/16
2	2 3/8
2 1/2	2 7/8
3	3 1/2
4	4 1/2
5	5 1/2
6	6 5/8
7	7 5/8
8	8 3/4
9	9 3/4
10	10 3/4
11	11 3/4
12	12 3/4
14 +	Equal to call out

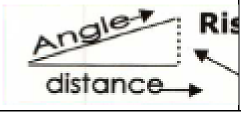
MATH

Math

Shapes and Formulas

Square or Rectangle 	Area = Length X Width = lw Perimeter = 2 Lengths + 2 Widths = 2L+2W
Parallelogram 	Area = Base X Height = bh
Triangle 	Area = ½ of base X height = 1/2bh Perimeter = a+b+c (add length of 3 sides)
Apezoid 	Area = $\left(\frac{b1+b2}{2}\right)h$ Perimeter = area + b1 + b2+ c
Circle 	Circumference = distance around the circle = c Diameter = distance across the circle = d Radius = distance from center to point on a circle = r $A = \pi r^2$ $\pi = 3.14$ D= 2r C= πd = 2 πr = πr ^{2}

Prism 	Surface Area = 2b+Ph (b is area of the base) (P is perimeter of base) Volume = Base X Height = bh
Cylinder 	Surface Area = $2\,\pi\,rh$ (Radius X Height) Volume = $\pi r^{2} X\ heig$
Pyramid 	Surface Area = Add Area of base to the sum of all areas of all triangular faces. The areas of triangular faces will have different formulas based on the shapes.
Cone 	Surface Area = $\pi r^{2} + \pi rs$ Volume = $\frac{1}{3}\pi r^{2} X\ heigh$
Sphere 	Surface area = $4\pi r^{2}$ Volume = $\frac{4}{3}\pi r^{3}$

Rise 	Tangent of the angle X the distance = the rise

Mitres:

Mean Radius ±1.2 O.D X 1/2 π (pi) ÷ Miters

Lags:

O.D. ÷ I.D. X ILS = (OLS)
ID ÷ OD X OLS = (ILS)

Figuring Lag Sizes

Dims Required: ID of Insulation, OD of Insulation, Inside Lag size or outside lag size.

Formulas:

OD ÷ ID X ILS = OLS

ID ÷ OD X OLS = ILS

Set up the equation as follows, inside numbers on top.

Always cross multiply then divide.

Finding the inside lag size

Hold a ruler up the side of the tank, vessel or pipe to be insulated. (Image on page 54)

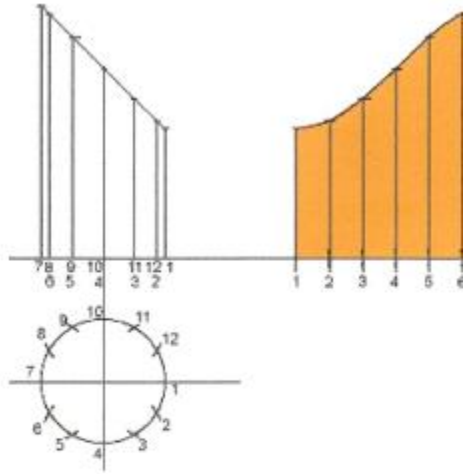
Looking down the rules note the measurement before the deflection on each side of where the rules touches is to much (roughly 1/8" gap). This measure is the ILS.

Tip: Consider the material being used. MF is less rigid than cal-sil, there fore due to compression of the material the MF lag size may be wirder (more delfection when measuring).

Parallel Line Development

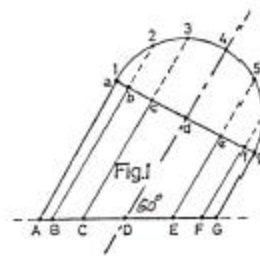
The parallel line method of pattern development is based on a system of lines drawn parallel to one another on the surface of a sheet metal article and is used to develop items such as elbows, segmental bends, Tee-pieces or valve boxes for example. In general, it is used to develop square, rectangular and cylindrical shapes (prisms). An example of parallel development can be seen below.

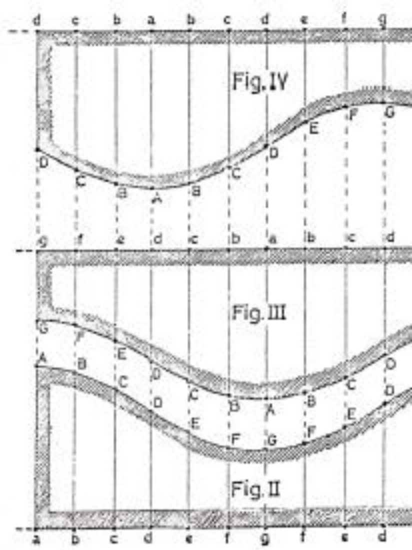
below.



Truncated Cylinder

The diagram below shows a truncated cylinder developed by parallel line development. On the left is the elevation with all lines shown for developing the cylinder and on the right is the actual pattern or development.





The following diagram shows a pipe socket cut at an angle-Table 1.

Figure I: Shows the elevation.
Figure II: Development, the seam is on the outside, on line A-a.
Figure III: Development, the seam is on the inside, on line G-g.
Figure IV: Development, the seam is on the side, on line D-d.

In figure 1, I first draw the elevation of the pipe socket. This is done by first drawing the horizontal line AG. Next draw the line D-d at an angle of 60° to AG. When the centreline length of D-d has been determined, draw the baseline a-g at right angles to the centreline as shown. Draw the semicircle with the centre at point d on the middle line of the pipe and divide into 6 equal parts. This gives us points 1-7 on the arc. Then draw parallel lines to the middle line through points 1, 2, 3, 4, 5, 6 and 7, thus finding points a to g and A-G.

The Development of Figure 2

On the base line lay off the line segment 1 to 2 (of the arc in figure 1) 12 times. This gives us points a to g or the circumference of the pipe socket. Draw the perpendicular lines at these points and lay off the respective line segments of figure 1, i.e. aA, bB, cC, etc. The connecting line of these newly found points is a curve. It is very important when stepping off the 12 equal arc lengths or divisions not to accumulate an error which would make the circumference longer or shorter than required. The developments for figure III and figure IV are obtained in the same way.

Note: The pipe can also be developed by calculating it's circumference (diameter x π) and then by dividing the circumference in half, quarters, and then each quarter into three equal and accurate divisions with no accumulation
or error.

1.2 Position of Joint lines

We always aim to put the joint line on the shortest side. The reason it is put there is to save time and effort. Sometimes we put the joint elsewhere for appearances of a job or to maximize use of metal. On the development shown above the joint is positioned on the line A-A as this is the shortest side of the pattern.

There are many joints in sheet metal. Some joints are called self-secured joints. This is where we use the job's own metal. Examples are Groove joint, Slip joint and Peined joint. They all have different amounts of metal involved in their assembly. It is important to allow for these joints when marking out a pattern.

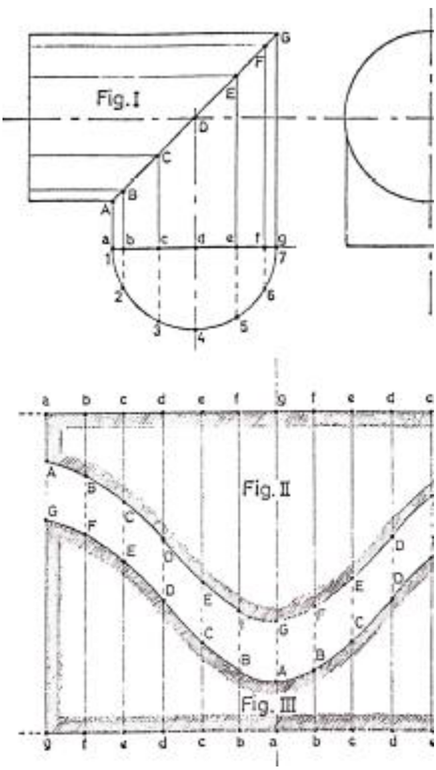


Figure I, shows the elevation.
Figure II, development of the lower socket, seam on the inside.
Figure III, development of the lower socket, seam on the outside.

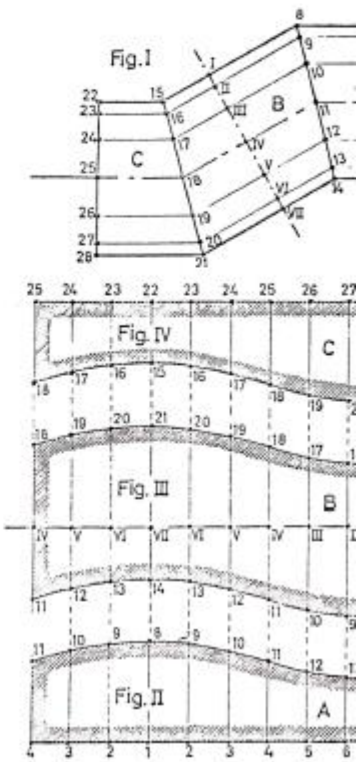
After determining the outline of the elevation of figure I as mentioned in section 1 above, draw the semi-circle at point d, divide into six equal parts and through points 2 and 6 draw the so called generating lines parallel to the middle line. The joint line of the two pipe sockets is a straight line. The development is obtained as described in table 1 by laying off the line segment 1 to 2 (or the arc in figure1) 12 times on a base line, drawing the perpendiculars at points a to g, and on these points laying off the respective line segments aA, bB, etc. of figure I. As mentioned above, it is very important when stepping of the 12 arc lengths or divisions not to accumulate an error which would make the circumference longer or shorter than required.

Note: The pipe can also be developed by calculating it's circumference (diameter x π) and then by dividing the circumference in half, quarters, and then each quarter into three equal and accurate divisions with no accumulation or error.

2.2 Development of an Offset

Figure I: Elevation.

Figure II: Development of socket A.
Figure III: Development of socket B.
Figure IV: Development of socket C.



First determine the outline of the elevation of the offset in figure I and take care to give the three segments or pipes the correct diameter. Then draw the semicircle with the centre at point 4, divide it into six equal parts and through points b, c, e, and f draw the so-called generating lines parallel to the middle lines of the three segments. The development of the two sockets A and C is described in the previous tables above. For the development of the middle socket B draw the auxiliary line 1 to 7 perpendicular to the middle line in figure 1. This auxiliary line is constructed at a random point on the centreline 11 to 18. The generating line yields points 1 to 7.

For the development of figure III determine the base line with points 1 to 7 as usual. Draw the perpendiculars at these points and on these lines lay off the various lengths of the lines above and below the base line. All these lines should be the same length.

2.3 Development of a 90º Segmental bend -1

Full, 2 Half Segments

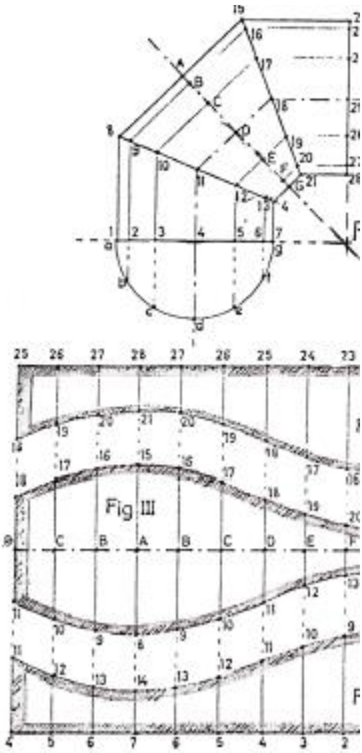


Figure I: Elevation.
Figure II: Development of the upper segment.
Figure III: Development of the middle segment.
Figure IV: Development of the lower segment.
After determining the outline in figure 1 draw the semicircle with the centre at point 4. Divide it into six equal parts and draw the generating lines parallel to the middle lines thus intersecting the mitres at points 8 to 14 and 15 to 21.

The line segments 1 to 8, 2 to 9, 3 to 10, etc are the lengths needed for the development, which is performed as usual.

2.4 Development of a 90º Segmental Bend -5

Full, 2 Half Segments

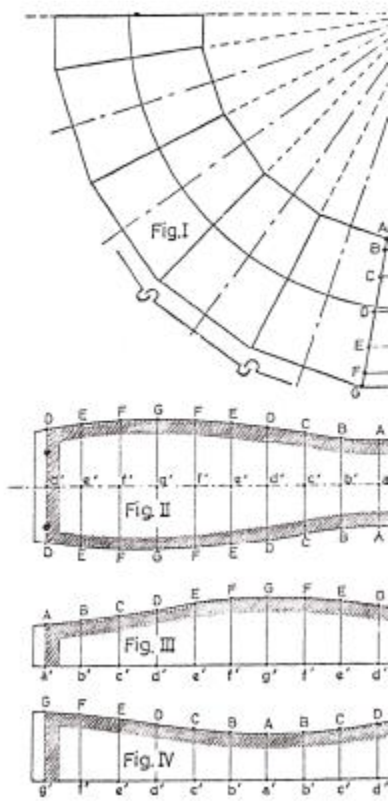


Figure I: Elevation.
Figure II: Development of a full segment, seam on the side.
Figure III: Development of a half segment, seam on the inside.

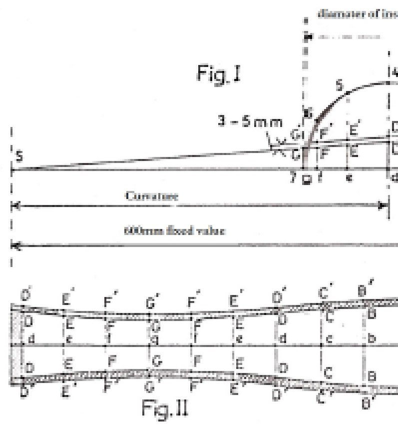
Figure IV: Development of a half segment, seam on the outside.

With the centre point S and the previously measured radius of curvature Sd in figure I draw a 90° arc and divide it into the desired number of segments observing that at the two ends only half segments are needed.

Then draw the semicircle with centre at point d and divide it into six equal parts. Draw the necessary perpendiculars, finding points A to G and a to g. Then, at a distance of 3 to 5 mm draw a parallel line to the base line a g containing points a1 to g1 (allowance for beaded piece).

The Development of Figure 2

Lay off the full circumference as mentioned in Table 1 on a base line d-d and at the found point a1 to g1 draw 13 perpendiculars. On these lines lay off on both side the respective line segments Aa, Bb, Cc etc of figure I and connect the newly found points. The developed segment then has the so-called fish shape. The developments as in figure III and figure IV, with seams on the inside and outside respectively, are obtained in the same way. The developments differ only in order of the generating lines.



Addition for bead 3-5 mm

Addition for overlap 15 - 20mm

Number of segments	Hi
4	160
5	119
6	95,
7	79,
8	67,
9	59,
10	52,
11	47,
12	43,
13	39,

2.5 Segmental Joints (Simplified)

Figure I : Elevation.

Figure II: Development.

On the base line Sp lay off the measured radius of curvature from point to d.

With d as the centre, draw a semicircle with the radius of the outer diameter of the insulation. Divide it into six equal parts and from this find points 2 to 6 and draw the perpendiculars to the base line. Lay off 600mm from point s to point p, which may be inside or outside the semicircle, and draw the perpendicular at p and lay off the respective value of x found in the chart and place at point Q.

From point Q draw the connecting line S intersecting the perpendiculars of the semicircle at points A to G. The line segments aA, bB, etc. are the parts needed for the development in figure 2.

In figure 2 the allowances for the male/female seam and for the overlap are already added. The allowances for the beaded pieces in the elevation can be added at the base line or better still at the mitre lines as done here.

2.6 Efficient Drawing Layout and Sequencing of Layouts

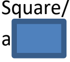
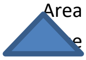
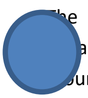
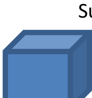
Today it is customary in the insulating industry to develop fittings according to **section 2.5** above. When cutting the plates to size, metal waste and cutting can be reduced by alternatively laying the various segments one under the other. It is very important to nest the various patterns together to maximise economy of materials. Also the connection of the individual segments is almost only made with a beaded piece and counter piece as shown under the arc in figure 1. The average allowance for the beaded pieces is 8 mm, in other words 4 mm for half the development. For smaller pipes and small beaded pieces 3mm is enough of an allowance.

Refer to Module 1 – Unit 9 – Metal cladding assembly work.

Refer to Module 1 – unit 5 – General allowances for insulation and cladding.

Refer to module 1 – unit 4 – Notching, folding and joining.

Shape Math

Shape	Formulas	
Square/Recta 	Area = Length X Width Perimeter = 2 X Lengths + 2 X Widths	A = lw P=2l+2w
Parallelogram 	= Base X Height	A=bh
Triangle 	Area = ½ e X height Perimeter = add length of three sides	A = 1/2b h P=a+b+c
Trapezoid 	Area = b2/2)h Perimeter = area+b1+b2+c	P=a+b1+b2+c
Circle 	The ance und the circle is circumference= c. Distance across is the diameter = d Radius = r the distance from the center to a point on the circle	D=2r $C=\pi d=2\pi r$ $A=\pi r^2$ $\pi=3.1415$
Prism 	Surface Area = B+Ph B = area of the base P = perimeter of the base Volume = base X height	
Cylinder 	face a = 2π radius x height Volume= πr^2 x height	$S=\pi rh$ $V=\pi r^2h$
Pyramid	Surface Area: Add area of base to sum of the areas of the triangular faces. The areas of the triangular faces will have different formulas for different shaped bases.	
Cone	Surface Area = $\pi r^2+\pi rs$ Volume=1/3 πr^2X height	
Sphere	Surface Area = 2 πr h Volume = 4/3 πr^3 Tangent of	

the angle X
the
distance =
the rise

LINE AND CIRCLE DIVISION

Line Division

Mathematically:

Use easy math when possible.

Basic Geometry:

Using dividers set more than half the line length. From each end of the line scribe inward creating common apex's above and below the line. Join the apex's with a straight edge creating a center point.

Ruler Method:

Draw a line on one end of the horizontal line at 90°. Using a rule place one end of the horizontal line. Slide the other end up the vertical line until you reach a number divisible by the number of divisions required.

Trial & Error:

Guessing—Set Dividers—Step off required number of divisions. Divide the remainder by the number of divisions. Add this number to the divider, step off again.

Circle Division (Bisecting)

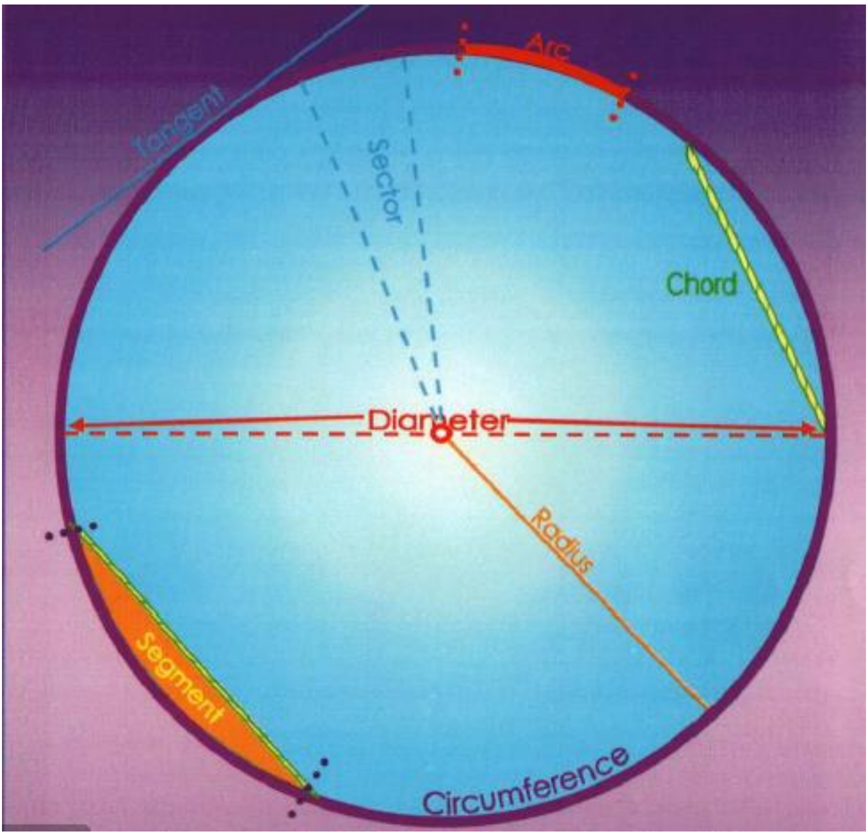
Important!!
Draw cross hairs then add circle.

Place dividers on quarter point set to just over half a 1/4 point and scribe outside the circle slightly. Repeat for next 1/4 point joining arcs for a common apex. Repeat as required.

Bisecting by thirds:
After scribing circle keep radius setting. Scribe for 1/4 points both ways onto the circle.

Parts of a Circle

1. Diameter
2. Radius
3. Segment
4. Chord
5. Sector
6. Tangent
7. Circumference
8. Arc



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Bisecting by thirds:
After scribing circle keep radius setting. Scribe for 1/4 points both ways onto the circle.

REFERENCE CARDS

K-Factor

"**K**" is the thermal conductivity of a material as defined by ASIM (American Society of Testing Materials) as follows:
The amount of heat (BTUs) transmitted through (1) square foot of material (1) inch thick, in (1) hour with a temperature differential of 1°F between the two surfaces of insulation, @ the average or mean temperature of the material.
BTU One (1) BTU is approximately the amount of heat required to raise the temperature of one (1) pound of water.
Mean Temperature:
The artthemtical average between hot and cold faces of insulation.
Example: Pipe temp 200°F, outside temp of insulation 80°F: 200+80 ÷2=140°F (Mean Temp.)

Comparative Insulation Efficiency

The lower the "K" value the better the insulation.
R value = Thickness of Insulation ÷ "K" Factor

Material	K Factor @ 75°F
Foam glass	0.37
Rock Wool (Batts)	0.32
Asbestos Fibre	0.30
Styro Span	0.26
Fibreglass AF 320 3/4 LB	0.26
Fiberglass AF 327 1 LB	0.24
Rigid coated duct	0.24
Fiberglass AF 545	0.23
Fiberglass pipe insulation	0.22
Urethane Foam	0.12 –0.16

Elbows

90 Degree Pressed Elbows					
Iron Pipe Size	Insulation Thickness				
	1	1 1/2	2	2 1/2	3
1/2	2	5	8	12	23
3/4	2	5	9	12	23
1	3	6	11	12	23
1 1/4	3	9	11	18	23
1 1/2	4	9	18	23	15
2	7	10	18	20	24
2 1/2	13	16	20	24	25
3	14	19	22	24	25
3 1/2	17	21	27	30	33
4	17	21	27	30	33
4 1/2	28	27	30	38	31
5	28	29	36	38	39
6	32	35	37	39	44
7	35	37	39	44	45
8	41	42	43	47	49
9	42	43	47	49	52
10	46	50	51	55	54
11	50	51	52	56	-
12	48	55	56	-	-

Elbows Continued

45 Degree Pressed Elbows					
Iron Pipe Size	Insulation Thickness				
	1	1 1/2	2	2 1/2	3
1/2	1	3	5	7	8
3/4	1	3	5	7	8
1	2	4	6	7	8
1 1/4	2	5	6	7	8
1 1/2	3	5	7	8	9
2	4	6	7	8	9
2 1/2	5	7	8	9	10
3	6	7	8	9	10
3 1/2	7	8	9	10	11
4	7	8	9	10	11
4 1/2	8	9	10	11	12
5	8	9	10	11	12
6	9	10	11	12	13
7	10	11	12	13	14
8	11	12	13	14	15
9	12	13	14	15	16
10	13	14	15	16	17
11	14	15	16	17	18
12	15	16	17	18	19
14	16	17	18	19	20
15	17	18	19	20	21
16	18	19	20	21	22
17	19	20	21	22	-
18	20	21	22	-	-
19	21	22	-	-	-
20	22	-	-	-	-

End Caps

End Caps				
Call Out Size	**Diameter "**	**3/4" Crimp**	**3/16" Easy Edge**	**Cut & Roll**
#5	5	3 1/4	2 11/16	17 11/16
#6	5 1/2	3 1/2	2 15/16	19 1/4
#7	6 5/8	4 1/16	3 1/2	22 13/16
#8	7 5/8	4 9/16	4	25 15/16
#9	8 5/8	5 1/16	4 1/2	29 1/8
#10	9 5/8	5 9/16	5	32 1/4
#11	10 3/4	6 1/8	5 9/16	35 3/4
#12	11 3/4	6 5/8	6 1/16	38 15/16
#13	12 3/4	7 1/8	6 9/16	42 1/16
#14	14	7 3/4	7 3/16	46
#15	15	8 1/4	7 11/16	49 1/8
#16	16	8 3/4	8 3/16	53 1/4
#17	17	9 1/4	8 11/16	56 3/8
#18	18	9 3/4	9 3/16	59 9/16
#19	19	10 1/4	9 11/16	62 11/16
#20	20	10 3/4	10 3/16	65 13/16
#21	21	11 1/4	10 11/16	69
#22	22	11 3/4	11 3/16	72 1/8
#23	23	12 1/4	11 11/16	75 1/4
#24	24	12 3/4	12 3/16	78 3/8

5. Repeat for insulation radii. Then pip radii—using same center point for all 3 circles.
6. Cut out and fabricate removing less than 1/4 for closure when applying.

Calculating Elbows

Mean Radius MR
Long Radius 1 1/2 times callout size
Short Radius equal to call out size (as measured from the apex of the two welds.
Formulas: OD includes insulation
Heel: (MR+1/2 OD)*1/2 Pi ÷ Number of Mitres
(12X1 1/2 LR)(18-8=10)X1.57÷10=1.57"

C Bevels: Square Method

1. Draw a 90° angle large enough to fit the OD of the pipe covering. (Legs)
2. Mark pipe radius on both legs.
3. Mark <u>Insulation</u> radius on both legs. Connect matching radii. Extend line for insulation radii, outward to allow for crimp.
4. Set dividers from insulation thickness -> crimp allowance. Then scribe a circle.

Iron Pipe Sizes: Call out versus Actual

3/8	5/8
1/2	7/8
3/4	1 1/8
1	1 3/8
1 1/4	1 5/8
1 1/2	1 15/16
2	2 3/8
2 1/2	2 7/8
3	3 1/2
4	4 1/2
5	5 1/2
6	6 5/8
7	7 5/8
8	8 3/4
9	9 3/4
10	10 3/4
11	11 3/4
12	12 3/4
14 +	Equal to call out

Copper Pipe Call-out versus actual size

Call out size in "	Actual Size in inches	
3/8		
5/8		
7/8	1/2	IPS
1 1/8	3/4	IPS
1 3/8	1	IPS
1 5/8	1 1/4	IPS
1 7/8 & up	Equal to call out	

Pipe Wall Thickness (I.P.)

Call Out Size	Wall Thickness
1/2-2 1/2 inch	3/8-inch Total
3-5 inch	1/2-inch total
6-8 inch	5/8-inch total
10-12 inch	3/4-inch total

Note: Above 12 inch, the callout size is the actual O.D. of the pipe.

P-	401-	3”-	A150
(Process) Line Contents	Line #	Line Size	Flange Size

Work Rest Regimen for Hot Weather

Work Rest Regimen	Light Work Load (WBGT °C)	Moderate Work Load (WBGT °C)	Heavy Work Load (WBGT °C)
Continuous Work	30.0	26.7	25.5
75% Work 25% Rest Each Hour	30.6	28.0	25.9
50% Work 50% Rest Each Hour	31.4	29.4	27.9
25% Work 75% Rest Each Hour	32.2	31.1	30.0

Wind Chill Chart

WIND CHILL CHART

Wind km/h	Velocity mph	Ambient Temperature (∞C) 4	-1	-7	-12	-18	-23	-29	-34	-40
		Equivalent Chill Temperature (∞C)								
Calm 0	0	4	-1	-7	-12	-18	-23	-29	-34	-40
8	5	3	-3	-9	-14	-21	-26	-32	-38	-44
16	10	-2	-9	-16	-23	-30	-35	-43	-50	-57
24	15	-6	-13	-20	-28	-36	-43	-50	-58	-65
32	20	-8	-16	-23	-32	-39	-47	-55	-63	-71
40	25	-9	-18	-26	-34	-42	-51	-59	-67	-76
48	30	-16	-19	-22	-36	-44	-53	-62	-70	-78
56	35	-11	-20	-29	-37	-46	-55	-63	-72	-81
64	40	-12	-21	-29	-38	-47	-56	-65	-73	-82

Adapted from: Threshold Limit Values (TLV™) and Biological Exposure Indeces (BEI™) booklet; published by ACGIH, Cincinnati, Ohio

Little danger in less than one hour exposure of dry skin

Maximum danger of false sense of security

DANGER – Exposed flesh freezes within one minute

GREAT DANGER – Flesh may freeze within 30 seconds

Figure 1 Wind Chill Chart (https://www.ccohs.ca/oshanswers/phys_agents/cold_working.html)

Fractions and Decimals

Frac.	Decimal	Frac.	Decimal	Frac.	Decimal	Fraction	Decimal
1/64	0.015625	33/64	0.515625	17/64	0.265625	49/64	0.765625
1/32	0.03125	17/32	0.53125	9/32	0.28125	25/32	0.78125
3/64	0.046875	35/64	0.546875	19/64	0.296875	51/64	0.796875
1/16	0.0625	9/16	0.5625	5/16	0.3125	13/16	0.8125
5/64	0.078125	37/64	0.578125	21/64	0.328125	53/64	0.828125
3/32	0.09375	19/32	0.59375	11/32	0.34375	27/32	0.84375
7/64	0.109375	39/64	0.609375	23/64	0.359375	55/64	0.859375
1/8	0.125	5/8	0.625	3/8	0.375	7/8	0.875
9/64	0.140625	41/64	0.640625	25/64	0.390625	57/64	0.890625
5/32	0.15625	21/32	0.65625	13/32	0.40625	29/32	0.90625
11/64	0.171875	43/64	0.671875	27/64	0.421875	59/64	0.921875
3/16	0.1875	11/16	0.6875	7/16	0.4375	15/16	0.9375
13/64	0.203125	45/64	0.703125	29/64	0.453125	61/64	0.953125
7/32	0.21875	23/32	0.71875	15/32	0.46875	31/32	0.96875
15/64	0.234375	47/64	0.734375	31/64	0.484375	63/64	0.984375
1/4	0.25	3/4	0.75	1/2	0.5	1	1

Flange Size Chart

Pipe Size	150 #	300 #	400 #	600 #	900 #	1500 #
2	6	6.5	6.5	6.5	8.5	8.5
3	7.5	8.25	8.25	8.25	9.5	10.5
4	9	10	10	10.75	11.5	12.25
5	10	11	11	13	13.75	14.75
6	11	12.5	12.5	14	15	15.5
8	13.5	15	15.5	16.5	18.5	19
10	16	17.5	17.5	20	21.5	23
12	19	20.5	20.5	22	24	26.5
14	21	23	23	23.75	25.25	29.5
16	23.5	25.5	25.5	27	27.75	32.5
18	25	28	28	29.25	31	36
20	27.5	30.5	30.5	32	33.75	38.75
24	32	36	36	37	41	46

All measurements are in inches.
150# is considered a standard and will tolerate up to 150 Lbs. of pressure.

Head Segments

Dims Required: OD OC Segment length (1/4 Circumference), segment width, number of segments.

Calculating a Segment Width

Set a straight edge on the side of the head to determine the maximum width that can be used without deflecting on the sides.

Divide this measurement into the OC to get the number of lags (peels) required.

Adjust this number up or down to get a number that is easily divided by 4.

Redivide this number of segments into the circumference to get the actual segment width.

Quick Method:

Divide the OC by 24, 28, 30, 32, 36 or 40. This will give you the seg width.

Mathematical Method: (Special Only)

Draw the side view of the head (1/4 circumference)

Divide the 1/4 arc into equally spaced parts and label.

Draw lines from the center line 90° through the arch @ each of the divisions & measure each line to the arc.

Use the segment width formula on R1-7 to determine division widths (seg width X R1 –7 ÷ R1).

Head Segments: Stretch-out:

Cut a piece of metal 1/4 of the OC + Bottom lap.

Layout the segment length & divide into the same # of parts as the working drawing & label. Add a center line.

Mark 1/2 the measurements on each side of the center line. **Formula:** Seg Width X R1-7 ÷ R1 = S #s **Example:** 16^{mm} X $^{R3}30^{mm}$ ÷ 35 ^{mm} = 13.71 ^{mm}

Add Lap as required and use as a pattern.

Head Segments (Chalk line method)

Mark a centerline on the head from tip to edge.

Mark 1/2 the segment width on each side of the center line.

Place a chalk line on seg width lines and extend to head tip & snap a line.

Divide the center line into equally spaced parts and measure the seg width @ each of these divisions.

Lay out the seg length (1/4 OC) & divide into the same # of divisions as the head center line.

Transfer the measurements form the head to the stretch-out, add laps and process.

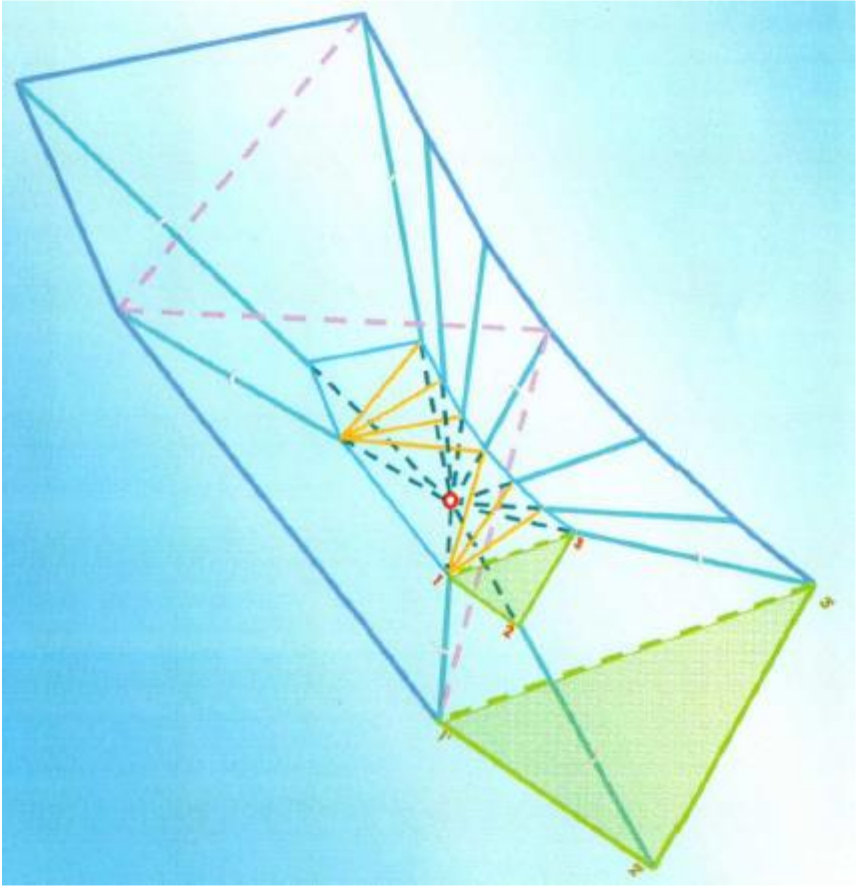
Head Segments:

See width X R1 –7 ÷ R1= Seg Widths

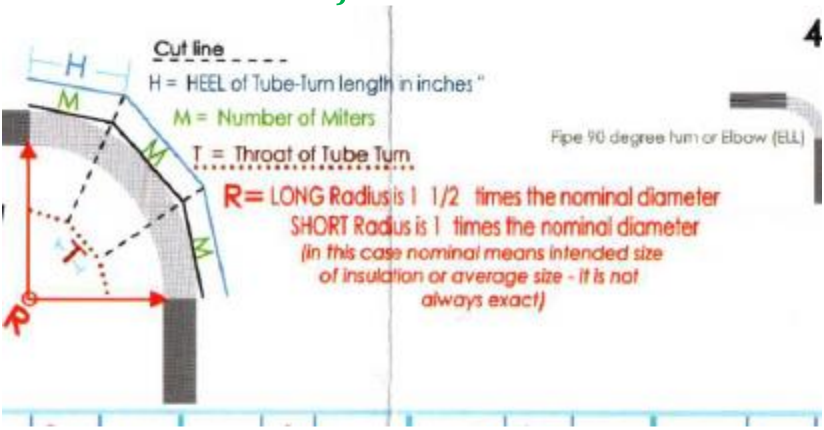
Enlarging or Reducing a Pattern

Example: To increase the size of this pattern to 3 times the original size, the corner 1-2-3 Is a right angle to 1’-2’-3’ also a right angle can therefor be made 3 times as large (in this case).

Draw construction lines for any arbitrary point O to the edge of the original pattern and add 2 more times the outside the original. This action increases the pattern size to 3 times the original. Other enlarging or reducing can be done the same way.



Long Radius Mitered Insulation Elbows (Long Radius Weld ELL Chart)



Page 42-44 of Local 7 book – type out in Excel

BEVEL AND END CAPS

Calculating Elbows

Mean Radius MR
Long Radius 1 1/2 times callout size
Short Radius equal to call out size (as measured from the apex of the two welds.
Formulas: OD includes insulation
Heel: (MR+1/2 OD)*1/2 Pi ÷ Number of Mitres
(12X1 1/2 LR)(18-8=10)X1.57÷10=1.57”

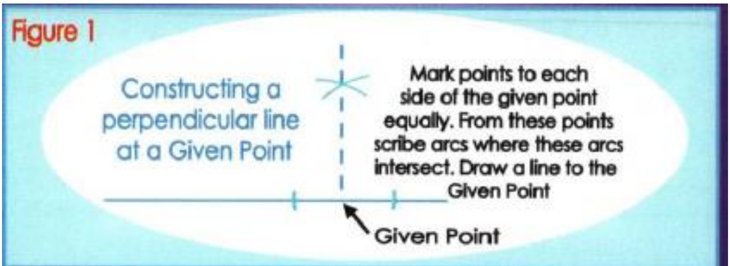
Bevels: Square Method

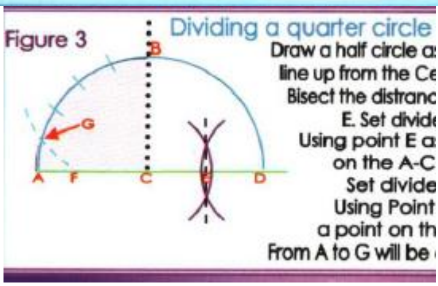
`

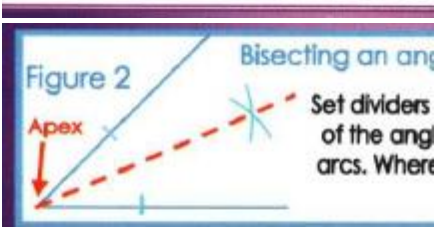
Mark pipe radius on both legs.
Mark Insulation radius on both legs.
Connect matching radii. Extend line for insulation radii, outward to allow for crimp.
Set dividers from insulation thickness -> crimp allowance. Then scribe a circle.
Repeat for insulation radii. Then pip radii—using same center point for all 3 circles.
Cut out and fabricate removing less than 1/4 for closure when applying

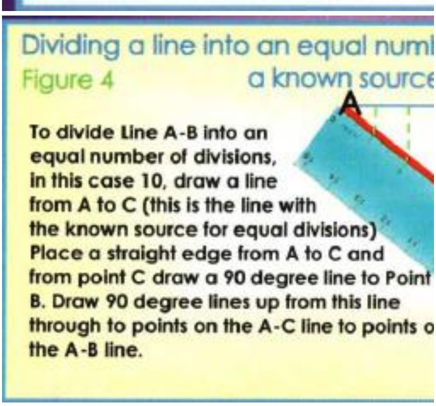
PATTERNS AND LAYOUTS

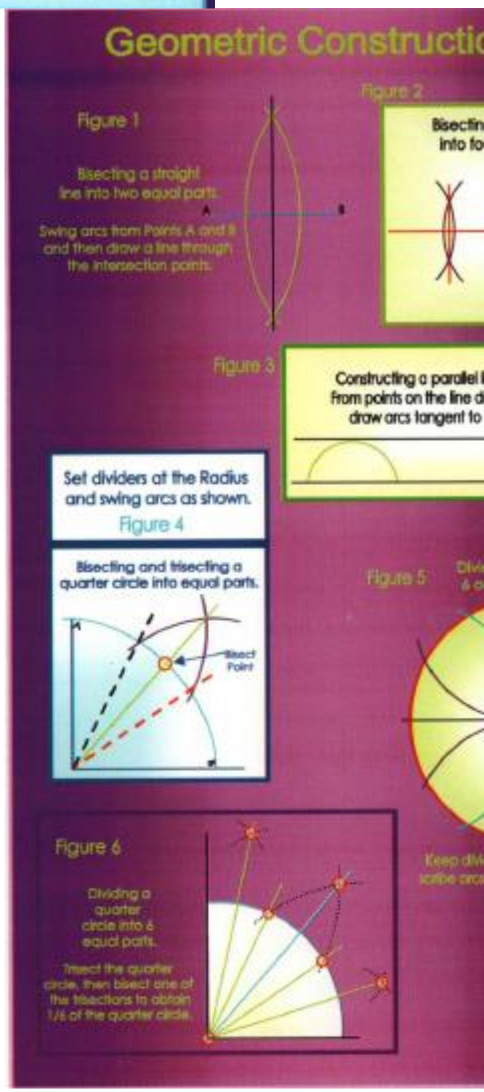
Geometric Construction





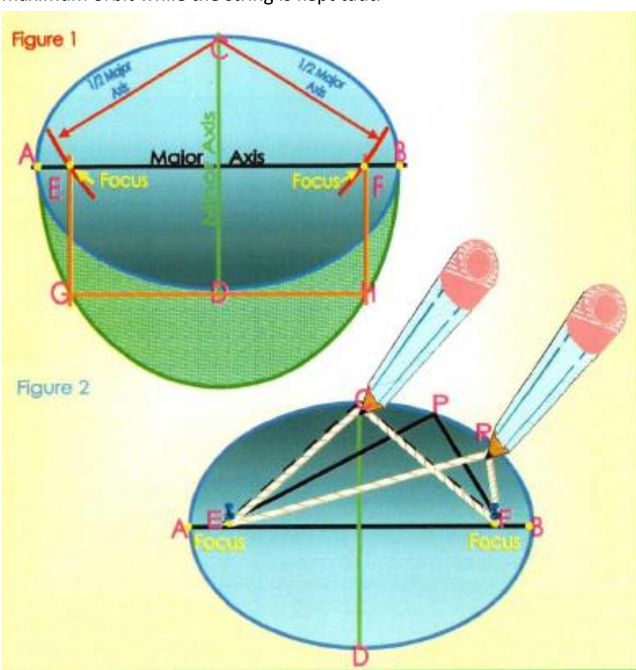






Ellipse Construction

The long axis of an ellipse is the major axis. The short axes is the minor axis. The foci E and F are found by striking arcs with the radius equal to half the major axis with the center at the end of the minor axis. Another method is to draw a semicircle with the major axis as diameter then draw G-H parallel to the major axis and G-E and H-F are parallel to the minor axis as shown. An Ellipse may also be generated by a point moving so that the sum of its distances from two points (the foci) is constant and equal to the major axis. For example, an ellipse may be constructed by placing a looped string around the foci E and F and around C, one end of the minor axis and moving the pencil point P along its maximum orbit while the string is kept taut.



Dividing a Circle into Equal Parts

Multiply the radius of the circle times the weight (a given number) that corresponds with the equal number of the parts used to divide the circle.

Number of Divisions	Weight Number	Number of Divisions	Weight Number
2	2.000	19	0.330
3	1.732	20	0.296
4	1.414	21	0.284
5	1.176	22	0.273
6	1.000	23	0.261
7	0.866	24	0.250
8	0.765	25	0.246
9	0.684	26	0.237
10	0.618	27	0.234
11	0.562	28	0.218
12	0.518	29	0.217
13	0.478	30	0.214
14	0.444	31	0.206
15	0.416	32	0.199
16	0.390	33	0.194
17	0.370	34	0.186
18	0.347	35	0.181
		36	0.179

Equal Tee

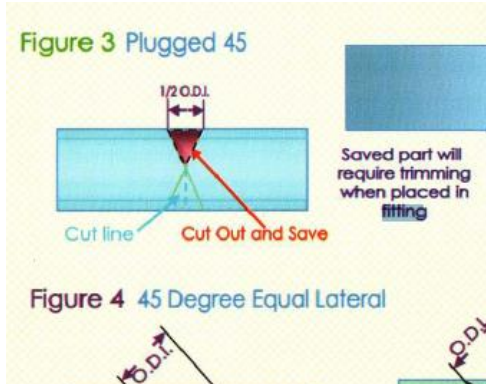
Dims Required =OD&OC Insulation. OC÷4

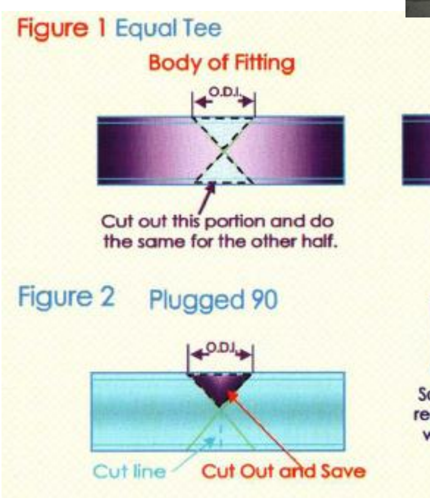
Tee Portion:

1. Cut a piece of metal equal to the OC+ LAP and ÷ into 4 equal parts (excluding LAP).
2. Set dividers to radius and scribe an arc in the lower corner. Then locate *A* 1/4 from the top of the arc.
3. Locate 1/8" *B* from 1/4 OC and mark
4. Using dividers step off 3 Radii. Use this setting to find the common apex then join *A* and *B*.

Body Portion:

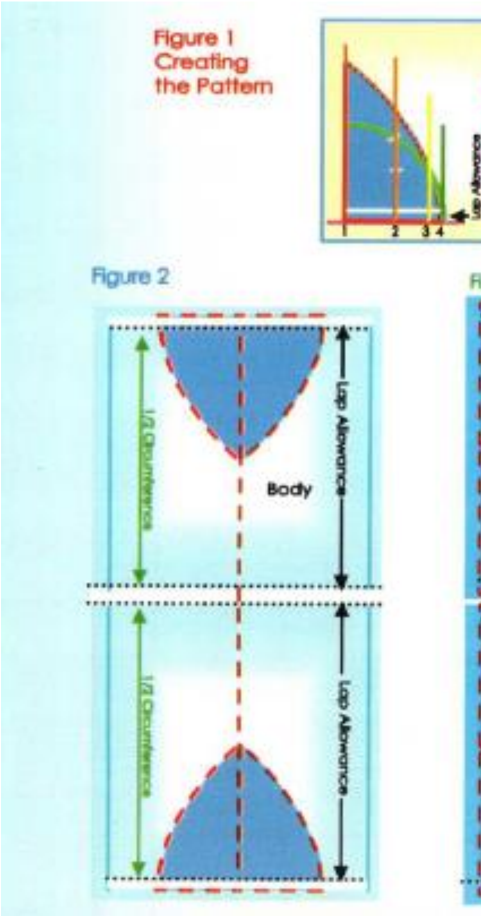
1. Cut a piece of metal equal to the OC plus LAP
2. Locate the center of the cut-out. Repeat "T" portion on both sides of the centre line.





Alternate Formula for Equal Tee

Step 1: Draw a 90-degree angle
Step 2: Using half the ODI set the dividers at the apex and swing a 90-degree arc from the vertical line to the base line
Step 3: Divide the arc into equal number of parts by bisecting or trisecting (in this case 3: larger tees require more divisions).
Step 4: Draw 90 degree vertical lines from the intersected points to the base line and number these points as shown
Step 5: Set dividers from 1 to 2 on the arc and on line 1, do 3 walk-ups and mark the top point. On line 2, do 2 walk-ups and on line 3 do 1 walk-up.
Steps 6: Connect all the points with point 4 from half the pattern.
Step 7: Cut out the pattern and for the stem portion of the fitting cut half the total circumference and place the pattern on the metal
Step 8: For the other half of the fitting allow for laps on both ends
Step 9: For the body portion of the fitting cut half the total circumference and place the pattern on the metal
Step 10: For the other portion of the fitting, add lap allowances at both ends.



Equal Tee

Dims Required =OD&OC Insulation. OC÷4

Tee Portion:

Cut a piece of metal equal to the OC+ LAP and ÷ into 4 equal parts (excluding LAP).

Set dividers to radius and scribe an arc in the lower corner. Then locate *A* 1/4 from the top of the arc.

Locate 1/8" *B* from 1/4 OC and mark

Using dividers step off 3 Radii. Use this setting to find the common apex then join *A* and *B*.

Body Portion:

Cut a piece of metal equal to the OC plus LAP

Locate the center of the cut-out. Repeat "T" portion on both sides of the centre line.

Unequal Tee

Dims Required: OD & OC of both pipes (Insulation included) & amount of change (depth of cheek)

Tee Portion

Cut a piece of metal equal to the OC of the small pipe + Lap, ÷ into equal number of parts (excluding LAP).

In the lower corner scribe an arc = the radius of the larger pipe

From the bottom of the arc, scribe a perpendicular line equal to the small radius.

Square the small radius and measure the depth of cheek. Transfer this measurement to the underside of the arc.

Draw a line across the metal indicating (depth of cheek).

Using the big radius alternate arc up and down at each 1/4 point.

Connect the arcs at the tangents using a ruler, flare if needed.

Unequal Tee

Dims Required: OD & OC of both pipes (Insulation included) & amount of change (depth of cheek)

Body Portion

Cut a piece of metal equal to the large OC + LAP.
Make a center line for the cut out.

Set dividers to the small radius and scribe an arc on both sides of the metal for the cut-out. (Use the center line as the divider point).

Move dividers into the metal 1/8 and re-scribe both sides.

Unequal Tee

Dims Required: OD & OC of both pipes (Insulation included) & amount of change (depth of cheek)

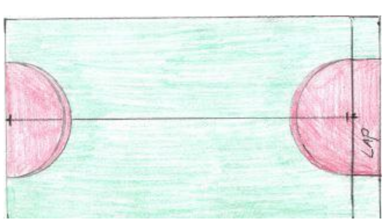
Tee Portion

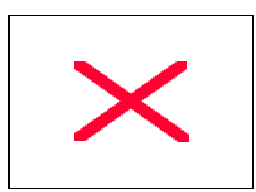
1. Cut a piece of metal equal to the OC of the small pipe + Lap, ÷ into equal number of parts (excluding LAP).
2. In the lower corner scribe an arc = the radius of the larger pipe
3. From the bottom of the arc, scribe a perpendicular line equal to the small radius.
4. Square the small radius and measure the depth of cheek. Transfer this measurement to the underside of the arc.
5. Draw a line across the metal indicating (depth of cheek).
6. Using the big radius alternate arc up and down at each 1/4 point.
7. Connect the arcs at the tangents using a ruler, flare if needed.

Dims Required: OD & OC of both pipes (Insulation included) & amount of change (depth of cheek)

Body Portion

1. Cut a piece of metal equal to the large OC + LAP. Make a center line for the cut out.
2. Set dividers to the small radius and scribe an arc on both sides of the metal for the cut-out. (Use the center line as the divider point).
3. Move dividers into the metal 1/8 and re-scribe both sides.





Another Formula for an Unequal Tee

Information Required: ODI for both sizes of pipe.

Step 1: Draw a base line with a 90-degree vertical line at each end. Plan enough room to draw the rest of the layout.

Step 2: Using half the ODI of the large diameter insulation, draw a 90-degree arc on the left vertical line as shown in figure 1. Do the same for the smaller ODI on the right vertical line.

Step 3: Draw a 90-degree vertical line between the 2 arcs and label it A.

Step 4: Trisect or bisect the small arc into equal parts (in this case 3)

Step 5: Draw parallel horizontal lines from the right bisected or trisected points on the 90 degree lines down to the base line

Step 6: Label the vertical lines 1 to 4 starting at the base line and extend those lines to the points on the small arc as shown in figure 3.

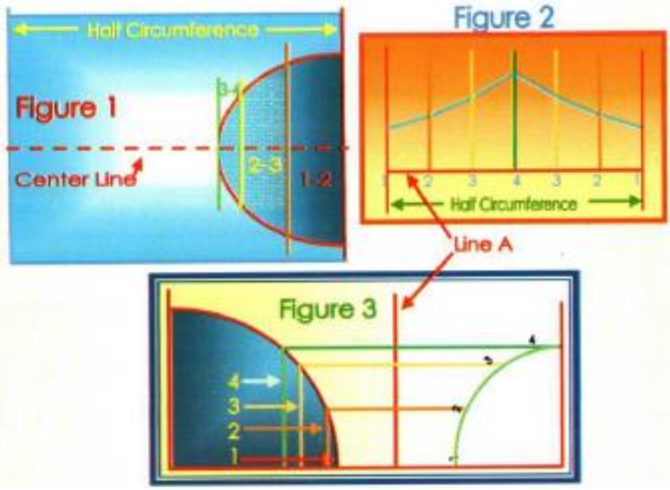
Step 7: Divide half the circumference into size equal parts and draw line A at 0-degrees to vertical lines for the sketch out.

Step 8: From figure 3 set dividers on the line A and line 1 on the large arc. Transfer this measurement to line 1 on your sketch-out. Do the same for the rest of the sketch-out, by advancing to the next number up each time. Fro the other half of the fitting add a lap.

Step 9: For the body portion of the fitting cut a piece of material half the circumference of the large ODI and draw a center line as in figure 3.

Step 10: From figure 3, set dividers at point 1 and point 2 on the large arc and transfer this measurement to the stretch-out as shown in figure 3. Do the same but stepping up from 2 to 3 then 3 to 4. Draw 0- degree lines on both sides of the center line through the points obtained and label those lines 1, 2, 3, & 4 as in figure 3.

Step 11: From figure 3 set dividers at the base line and point 4 on the large arc. Transfer this measurement to line 4 on the stretch-out in figure 3. Do the same for 3 and 2. 1 is just to a point. Connect all the points to obtain half the hole cut-out for the other half of the fitting. Add for a lap. In some instances, tabs may be required to lock the stem to the body.



Half Circumference
Figure 1
3-4
2-3
1-2
Center Line
Figure 2
1 2 3 4 3 2 1
Half Circumference
Line A
Figure 3
4
3
2
1

Layouts for Equal and Unequal Tees Stem Portions Only

Information Required: ODI, Circumferences of pipes

Step 1: Draw both views as shown in figure 1 and 2.

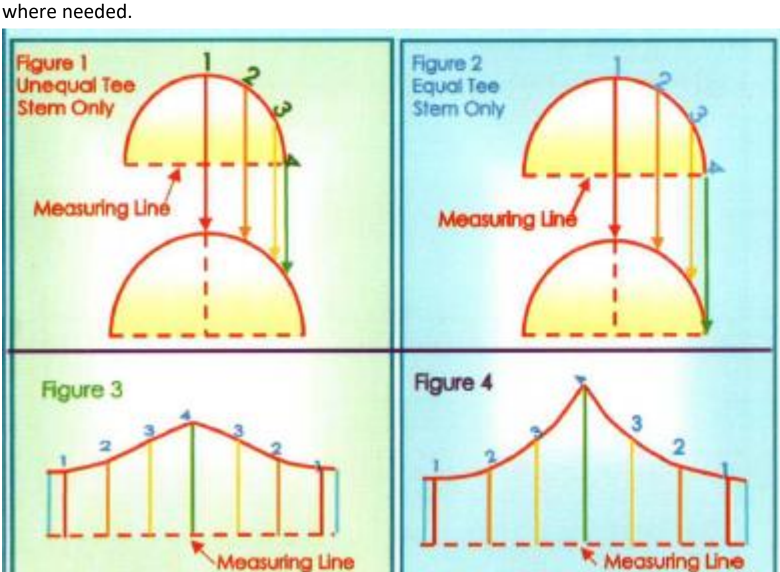
Step 2: Trisect the top quarter of the circles as shown.

Step 3: Extend lines down to intersecting points on the lower quarter circles.

Step 4: Divide the ½ circumference by 6 and draw a stretch-out as shown in figures 3 and 4. The reason to divide the circumference by 6 is because there are 3 equal divisions in a quarter circle. To obtain the number of divisions in a full circle multiply 3X2.

Step 5: From the measuring lines, measure to intersecting points on the bottom arcs. Transfer to corresponding numbered lines to the stretch-out.

Step 6: Connect all points to form the stem portions of the fittings. Add lap allowances where needed.



Another Method for Unequal Tees Stem Portion

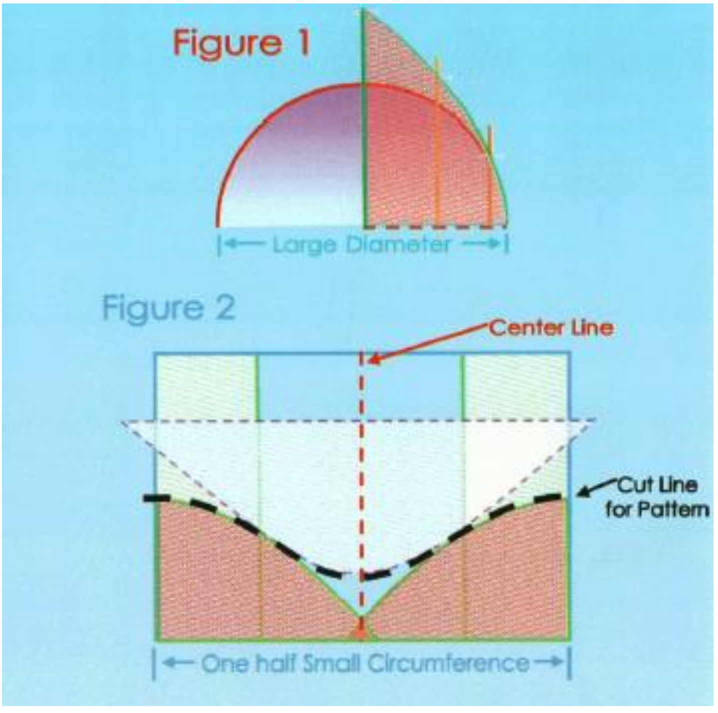
Information Required: Half circumference of small diameter insulation pattern for large diameter equal tee.

Step 1: Cut jacketing material for half circumference of the stem portion (small diameter) of the fitting.

Step 2: Divide this half circumference into four equal parts.

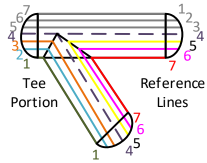
Step 3: Using the pattern for the large diameter equal tee. Place the pattern on the jacketing material as shown in figure 2.

Step 4: The previous steps creating half the fitting. For the other half add laps.



Equal Laterals

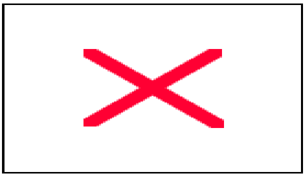
Dims Required: OD of pipe (Ins. Included)



Working Drawing

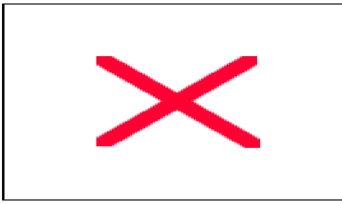
1. Draw the working drawing. Draw center lines, add OD of pipe and scribe arcs on all ends. Divide arcs equally and project lines into drawing and connect.

Tee Portion



1. Cut a piece of metal equal to the OC + LAP and ÷ into same number of parts as the working drawing and label.
2. Transfer dimensions from the working drawing to the stretch out.

Body Portion



1. Cut a piece of metal equal to the OC + LAP ÷ into same number of equal portions as the tee portion. Number according to LAP location.
2. Transfer points from body portion of the working drawing. #5 goes on line #3, #6 on #2, #7 on #1.
3. Take all dims from one side of the working drawing.

Steps for a 45-Degree Equilateral

Information Required: ODI, Circumference

Step 1: Draw a horizontal line with a 0—degree vertical center line and where they intersect draw a half-circle using half the ODI

Step 2: Trisect or bisect the semi-circle into equal parts from the horizontal line draw 90-degree lines up through these trisected or bisected points of the semi-circle. Label these lines.

Step 3: Using the radius set at half the ODI do one walk-up on line 1 and 3 walk-ups on line 7. Connect those points and label them as points A and B as shown in figure 1.

Step 4: Where the line drawn from 1 to 7 intersects with the center line. Label that point C

Step 5: Set dividers at points A and C and do 1 walk-up on the center line from point C to form point D.

Step 6: Connect these points going through A to D then to B.

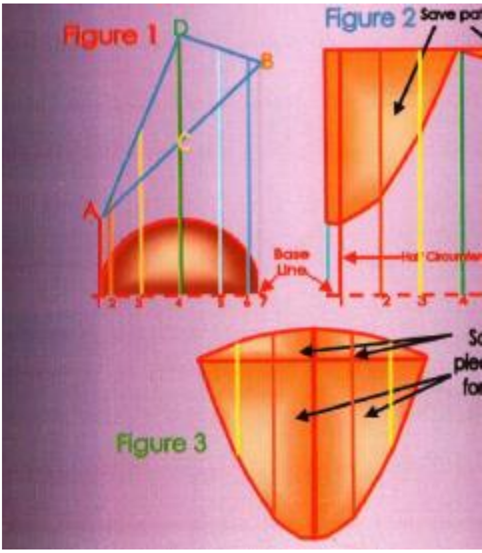
Step 7: Continue the vertical lines from the arc points to lines A, D and B.

Step 8: For half the stem portion of the fitting take half the circumference and divide that into 6 equal points. Label as shown in figure 2.

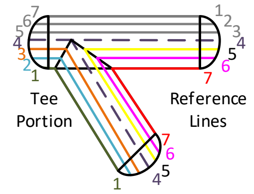
Step 9: Measuring from the base line to the A-D-B line, measure each line and transfer that measurement to the corresponding lines on the sketch-out and connect all of these points.

Step 10: Draw a 90-degree horizontal line from line 1 to line 7 making sure to intersect with line 4 (center line) as shown in figure 2. Save the portions as shown for the other portion of the fitting add a lap allowance.

Step 11: Using the cross-hair method, apply the pieces saved from step 10 to the cross-hairs as shown in figure 3. This will be the hold-cut-out. Add a lap allowance as required.



Unequal Laterals



Required Dims: OD Both pipes, OC both pipes (Ins included).

Working Drawing

1. Draw the working drawing. Start with the centerline of the large pipe (Top portion not required).
2. Draw a secondary projection downward form the body portion an d divide, carry division lines up to the body portion connecting at the arc, then across and down the pre-divided tee portion.

Tee Portion

1. Cut a piece of metal equal to the OC of the small pipe + LAP and Divide.
2. Using dividers transfer small pipe reference points to the stretch-out.

Body Portion

1. Cut a piece of metal equal to the large OC + LAP
2. Set dividers to along the large arc that were generated from the secondary projection. Transfer these individual widths into the circ of the metal.
3. Transfer the dimensions from the body portion of the working drawing. Take all dims from one side. #5 goes on line #3, #6 on #2, and #7 on #1.

Gore Elbows

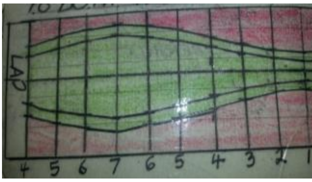
Dims Required OD, OC, Heel & Throat Measurements, Side & End Laps

Working Drawing

Cut a piece of metal equal to the OC + Total End Lap

Scribe a semi circle equal to the OD of the insulation. Divide into equal parts and add lines vertically and label.

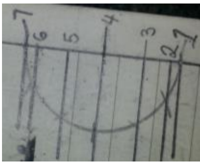
Place 1/2 the heel of 1 Gore on 1 end of the circle (#1 or #7) then place 1/2 the throat on of 16 gore on the line opposite the heel line, add 1/2 the total side up to these and scribe a line.



Stretch-Out

Cut a piece of metal equal to the OC+End Laps & Draw a center line along the OC length and divide into the same divisions as the working drawing.

Using dividers place one tip on the center line at the division intersections and scribe the corresponding working drawing dimensions to both sides of the centerline.



Compressed Gore Pattern

Scribe a vertical and horizontal lines large enough for the heel measurement to be placed on the vertical line.

Measuring up from the horizontal place 1/2 the heel measurement (of 1 gore) on the vertical line and 1/2 the throat on the vertical line also.

Find the center between the 1/2 heel and 1/2 throat and use dividers to join these with a semi circle.

Divide the semi circle into 6 equal divisions and label.

Transfer these points to the stretch-out as explained on the previous page.

Butterfly Gores

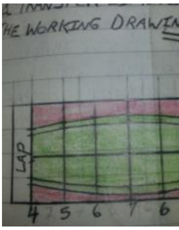
Dimas Required: OD, OC Heel, Throat, Total Side Lap, Total End Lap

Heel

Draw the working drawing

As with regular gore drawing cut metal to 1/2 OC plus laps

Divide into 6 equal parts & transfer dimensions from the working drawing.



Throat

Cut metal 1/2 OC + Lap & scribe cross hairs in the center.

Set dividers to radius and place 1 time in the center of crosshairs & scribe an arc on both sides of the centre of the metal.

Place 1/2 the total throat on each side of the center minimum 1/2” inch for band.

With dividers @ radius scribe arcs outward from the 1/2 throat marks.

Add laps and flares as necessary.

Snap-Line Gores

Information Required: Diameter of the tank with insulation, length of a gore

Step 1: To determine a gore's width, place a straight edge horizontally to the curvature of the tank and measure the distance that the straight edge rests against the tank. Allow for 1/8" on each site.

Step 2: Divide the width of the gore into the total circumference to determine the number of gores required to do the tank top.

Step 3: Adjust the width of the gore, by trial and error, until you get an equal number gores to equal the total circumference.

Step 4: Find the center of the tank top and stretch and chalk line to where the tank top starts to curve. Snap the chalk line there.

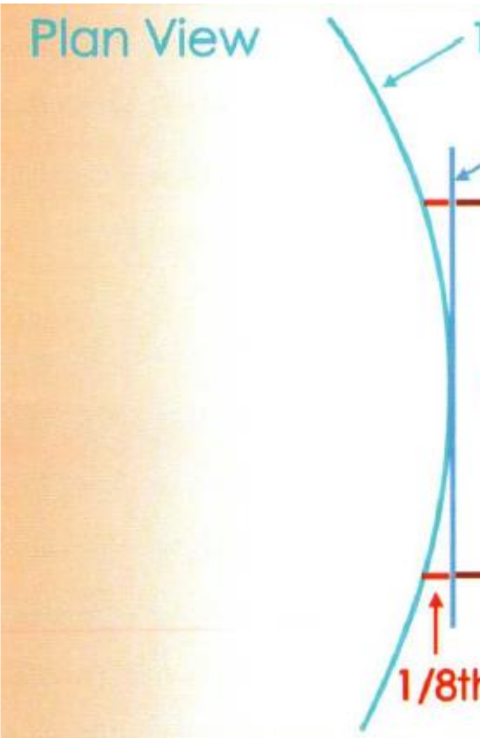
Step 5: Divide the width of a gore by two and, using the measurement, mark points to either side of the heel of the gore.

Step 6: Snap lines from each of these points to the center point of the tank

Step 7: Divide the distance from the tank top to the heel of the gore into equal parts (six or eight). Number these divisions accordingly

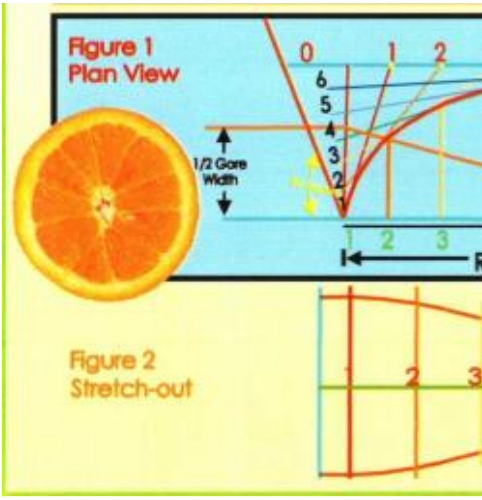
Step 8: Measure the widths and transfer to the corresponding numbered line on the Stretch-out.

Step 9: Add 3/8" to each side at the each division for the bead and crimp



Orangе Peel Gores

Information Required: Radius of the tank (insulation included), height of the tank head (insulation included)



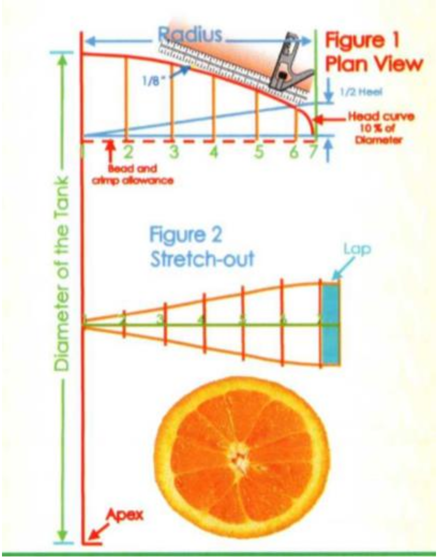
Step 1: Determine the correct width of a gore using trial and error.
Step 2: Divide the circumference by the width of a gore to determine the number of gores required for the tank top. Round up or down on the gore width to obtain the correct width to equal the circumference.
Step 3: Divide the gore width by two.
Step 4: Draw half a gore on the Base Line of the Elevation drawing.
Step 5: With the help of the horizontal and vertical division points, draw the curve for the top of the tank head. Start by drawing a rectangle that’s height is equal to the height of the tank and the length is equal to the radius of the tank. Draw an 80-degree line up from the left bottom corner and extend the top horizontal line to intersect the 80-degree line.
Step 6: Divide both 80-degree line and the top horizontal into six equal parts. Label the points as shown in figure 1.
Step 7: Connect points 1 to 1, 2 to 2, 3 to 3, 4 to 4, 5 to 5, 6 to 6. Draw the curve for the tank top.
Step 8: Measure the curve of the tank top and divide that length into six or equal parts
Step 9: Add 3/8” below the Base Line as shown in the figure below for the bead and crimp allowance.
Step 10: Draw lines to the bead and crimp line from the points drawing in step 8.
Step 11: For the gore Stretch-out, draw a center line and step-out the divisions of the tank top. Label the lines and add a lap.
Step 12: Take the measurement from Figure 1 and transfer to corresponding numbered points on the stretch-out. Connect all the points to form the pattern for the gores. Mark the bead, crimp and heel points.

Diameter Method for Orange Peel Gores

a. Diameter of the tank with insulation
b. Height of the tank top head with insulation
c. Heel size of the gore; obtain later.

Step 1: Draw a horizontal line one half the diameter of the tank
Step 2: Draw a vertical line equal to the height of the tank with insulation included. Carry this line down from the tank top to a point that equals the full diameter from the tank. This bottom point is the Apex.
Step 3: Set your dividers from the Apex to the tank top and swing an arc to form the tank top.
Step 4: Divide the diameter of the tank top by 10. Use this measurement to swing an arc intersecting arc to form the curve where the tank top and the side of the vessel meet.
Step 5: Divide the tank top into six or eight equal parts and label.
Step 6: Place a straight edge on the tank top head and allowing a gap of 1/8" on each side. Obtain a heel measurement. Round up or down as necessary to match the equal number of gores required to surround the total circumference.
Step 7: Draw half the heel measurement required for a gore at the outside edge of the tank to the right, and then draw a line from that point to the Apex as shown below.
Step 8: Draw a ½" crimp allowance at the bottom of the tank top.
Step 9: Divide the tank top into size equal parts and extend those lines down to the bead and crimp line. Label those lines.
Step 10: Draw a stretch-out by taking the distance from 1 to 2 on the tank top head and doing a six-division walk-out as shown. Label those lines as shown.

Step 11: Transfer the measurements from



the bead and crimp line to corresponding numbered lines on the stretch-out.
Step 12: Connect all the points on the stretch-out to form a pattern for the gores for the tank top. Add a lap allowance to the heel, usually 4-6"

Six Division Method for Orange Peel Gores

Information Required: diameter of the tank, radius of the tank, circumference of the tank, width of the gore heel, number of gores required – find by trial and error and central angle of one gore.

Step 1: Divide the radius and the height into six equal parts and label.

Step 2: Join like-numbers to form curve of the tank top; 1 to 1, 2 to 2, etc.

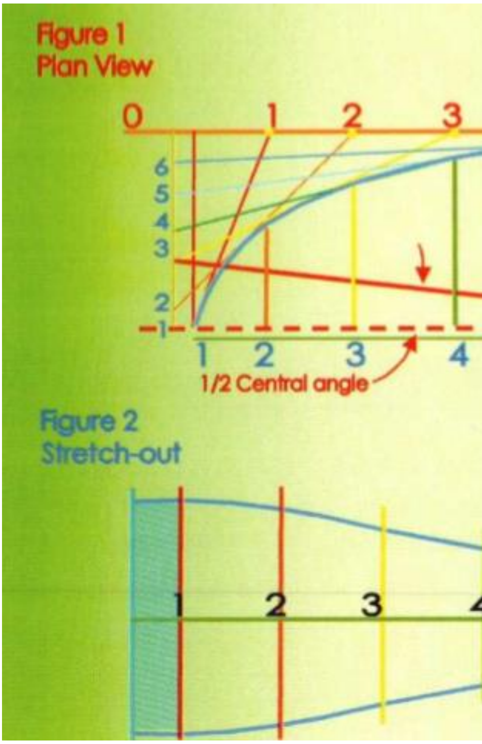
Step 3: Divide the tank top curve into six equal parts and extend the lines to the base line, and label as shown.

Step 4: To find the central angle, divide the number of gores required into the 360 degrees and then divide the central angle in half. Place this measurement on line 1 as shown.

Step 5: Add a ½” bead and crimp allowance to the base line.

Step 6: For the stretch-out, draw a horizontal line and use the division measurement from Step 3 to draw a stretch-out. Number the lines.

Step 7: Take the measurements from the bead and crimp line to the central angle line and transfer to the corresponding numbered lines of the stretch0out. Connect all the points to form the pattern for the gores. Add lap allowance to the heel, usually 4-6”

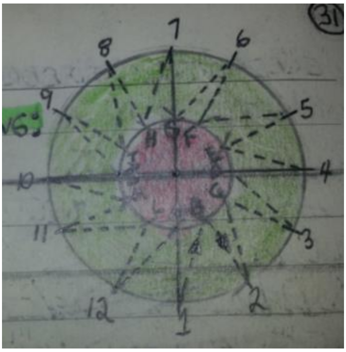


Concentric Reducer

Large OD Small OD Actual Height (Distance covered)

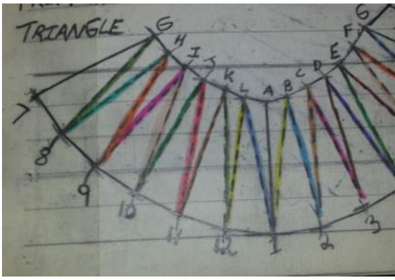
Radial Line Method

1. Using a piece of metal large enough for the amount of reduced to be done. Draw the side view.
2. Extend the sides up to a common apex.
3. Set your dividers from the apex to the top edge of the cone and scribe an arc.
4. Set your dividers from the apex to the bottom edge of the cone and scribe an arc.
5. Measure large OC and mark along the large arc line. Add LAP, cut away excess and assemble.



Triangulation

1. Draw the working drawing (End view)
2. Divide the large and small circles into equally spaced parts and label.
3. Draw the true length triangle. And mark the actual height.
4. Develop the true lengths and mark them on the triangle.
5. Develop the stretch-out start with the slant height on the center line.
6. Develop the other points along the stretch-out.
7. Connect the dots and develop the pattern.
8. Add flares crimp allowance and LAP



Working Drawing

Stretch-out: Transfer dimensions from the working drawing & true length triangle.

Eccentric Reducers

Dims Required: Large OD, Small OD, Actual or Slant Height

Draw the working drawing (end view)

Divide both arcs into equally spaced parts and label.

Draw your true length triangle and develop your true lengths

Develop the stretch-out start with a center line, transfer the actual height , triangulate the reducer using dimensions on the working drawing and the true length triangle.

Connect points using a ruler, add flares and laps if needed, cut out and fabricate.

Square to Square

Dims Required: Top Dimension, bottom dimensions, slant height.

Draw the working drawing (end view).

Draw the true length triangle and develop the true lengths

HINT: To find the actual height, place the A1 dimension from the working drawing on the horizontal line of the true length triangle, set dividers to slant height and scribe across the vertical line.

3. Develop the stretch-out using triangulation (2 points to find the third).

Square to Square Transition

Information Required: Include insulation in measurements a. small square dimensions, b. large square dimensions, c. true height

Step 1: Draw both elevation and plan views. On the plan view draw lines to the various points as shown in figure 2 and label those points as shown. Also on the elevation view draw a center line dividing the fitting in half.

Step 2: From the plan view take measurements from B-1 and transfer it to the elevation view. This measurement is placed on the horizontal line going from the center line to the right. Do the same for points A2 and A3. As this is an equal sized fitting we only need to measure on quarter of the fitting. Label these 3 points as shown.

Step 3: To start the layout, draw a line the width of the large square, divide this line into 2 equal parts and label as shown in figure 3. From point B draw a 90-degree vertical line, this will be the center line.

Step 4: From the elevation view set dividers at slant height B1 and transfer this set to the layout going from point B to an intersecting point on the center line to form point 1.

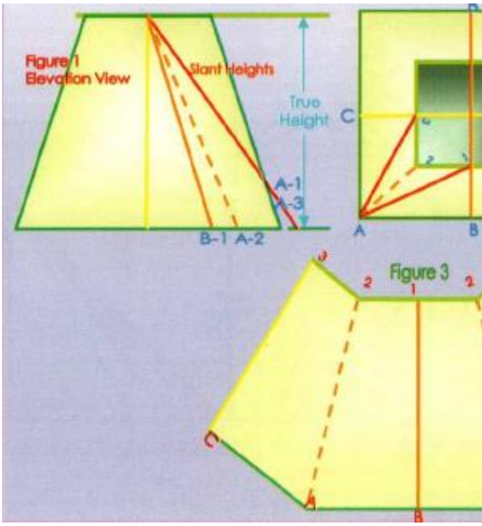
Step 5: Draw a 90-degree horizontal line to each side of point 1. These lines to each side will be half the dimension of a small square side. The ends of these lines will be labeled point 2.

Step 6: From both points 2, swing arcs to either side using half the small square dimensions.

Step 7: From the elevation view set dividers at slant height A3 and transfer to the layout using A as the apex and going to an intersection point on the last arcs drawing. Label this as point 3.

Step 8: Set dividers at slant height B1 and swing arcs off to the side of point A using point 3 as an apex. Then using half the square dimension, set dividers at point A and swing an intersecting arc to the last arc drawn to obtain point C.

Step 9: Connect all points to form half the fitting. For the other half add a lap.



Square to Round

Dims Required: Diameter, Perimeter, Actual or slant height.

Draw the working drawing (end view)

Divide the circle into equal parts and label. Also label square dimensions

Connect circle divisions to square connectors.

Draw the true length triangle & develop the true lengths

Use the dimensions from the working drawing and true length triangle to triangulate the stretch out, start with a center line.

Add flares and laps as required. Cut out and assemble.

Alternate for Square to Round

Information Required: (Include insulation in measurements) Turn height, square dimensions, round dimensions

Step 1: Draw a plan view and letter as shown. Mark the true height on the right vertical line.

Step 2: Trisect the bottom right quarter circle into equal parts and label.

Step 3: Set dividers at point A and point 1 and swing an arc from the base line to the right vertical line. Do the same for point 2. Points 1 and 4 intersect as do points 2 and 3.

Step 4: Set dividers at point S and point 4 and transfer to the horizontal line going from bottom right point A to the left. Label the points on the horizontal line as shown

Step 5: Draw lines from the apex (true height point) to all points on the horizontal line. These will be the slant heights.

Step 6: For the stretch-out draw a line the exact length of a square side and label both points A.

Step 7: From the plan view, set dividers at the apex and points 1-4 on the horizontal line. Transfer these points to the layout from both points A to an intersecting point on the layout to from point 1 on the layout.

Step 8: Using a second pair of dividers, take a set from 1 to 2 on the quarter circle of the plan view and on the layout draw arcs to both sides of point 1.

Step 9: From the plan view, set dividers at the apex and point 2-3 on the horizontal line and transfer them to the layout from both A points to intersect with the last arcs shown.

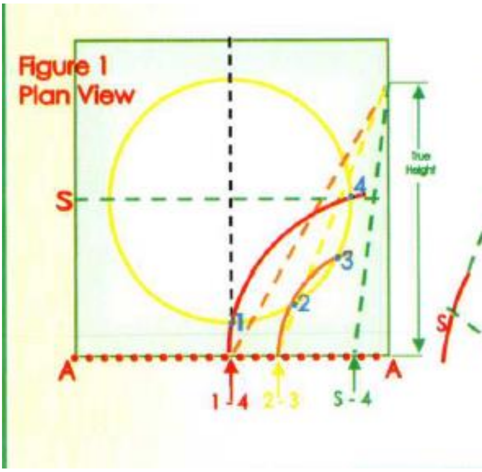
Step 10: Do the same to obtain points 3 and 4 on the layout.

Step 11: From points A, draw arcs to either side using half the distance of a square side.

Step 12: From the plan view set dividers at the apex the S-4 point and the 4 points on the layout draw intersecting arcs to the last arcs drawn. These points will be pint S on the layout.

Step 13: Connect all the points to form half the fitting.

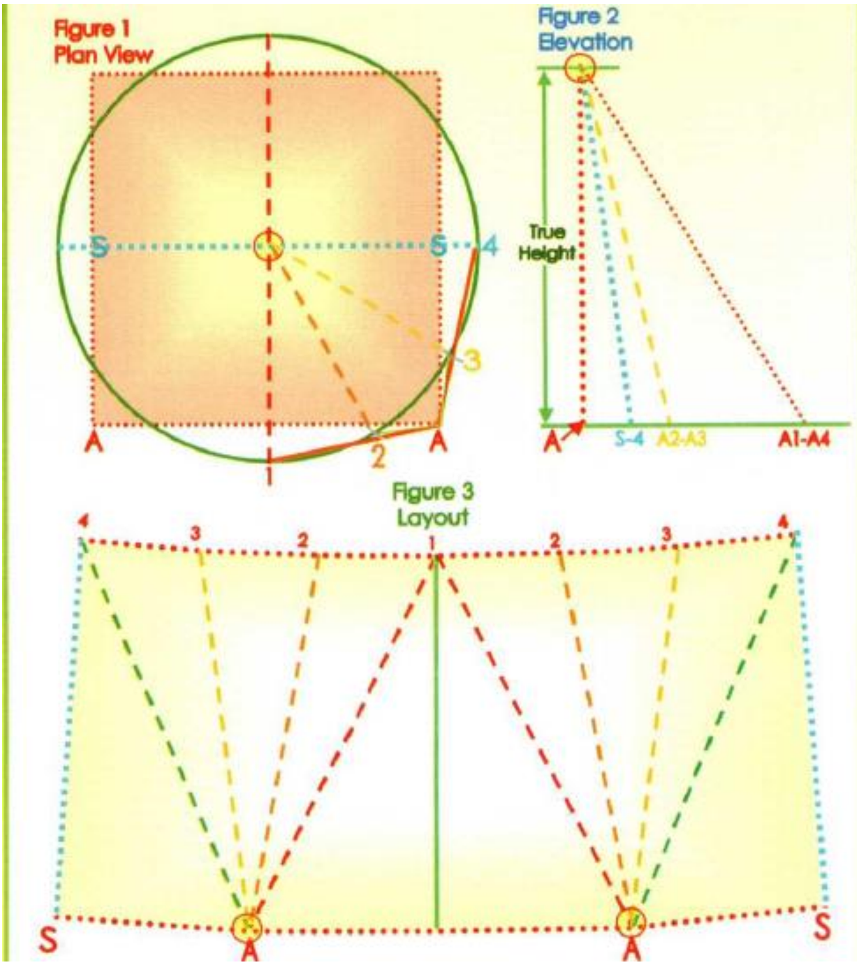
Step 14: Add for laps and notches where required.



Square to Round (Where Round is Larger)

Information Required: Square Dimensions, Round Dimensions, True Height

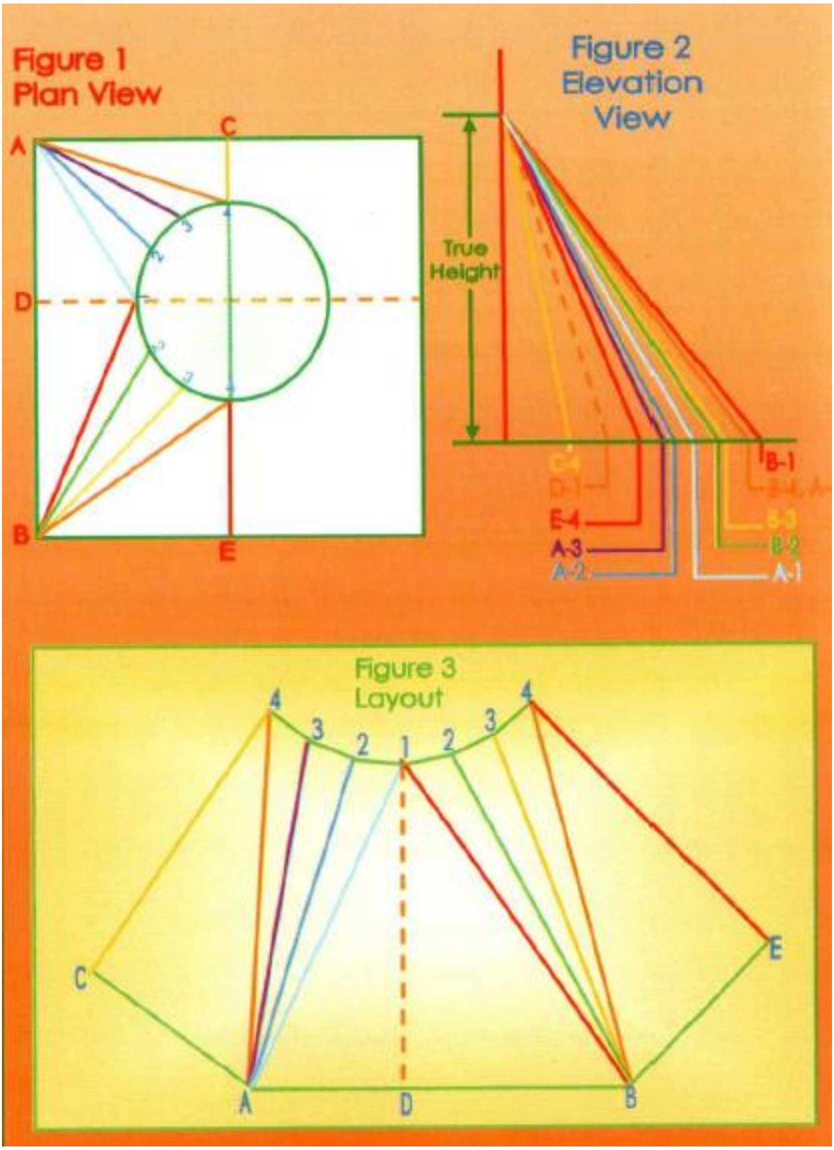
Steps: Use the same methods as a square to round layout.



Square to Round with Single Offset

Information Required: Square dimensions, round dimensions, offset dimensions, true height

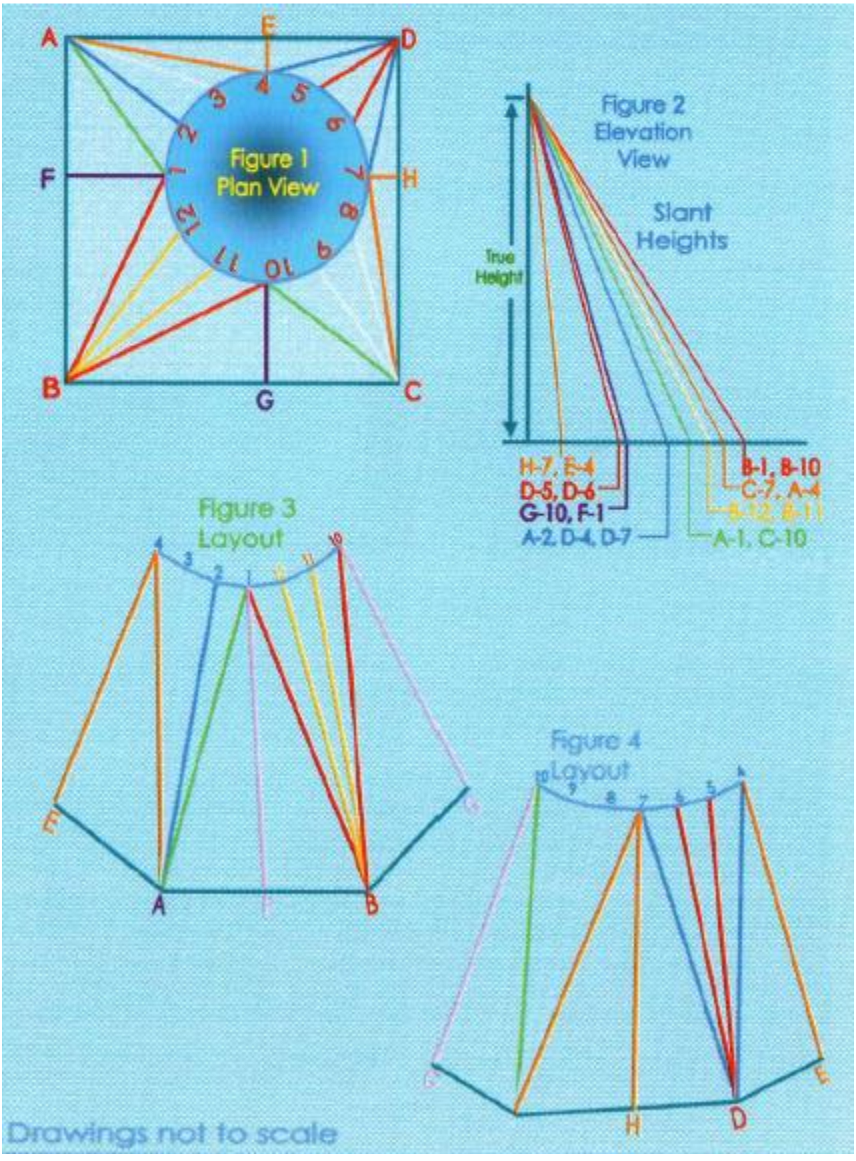
Steps are similar to square to round.



Square to Round with Double Offset

Information Required: Square dimensions, round dimensions, offset dimensions, true height

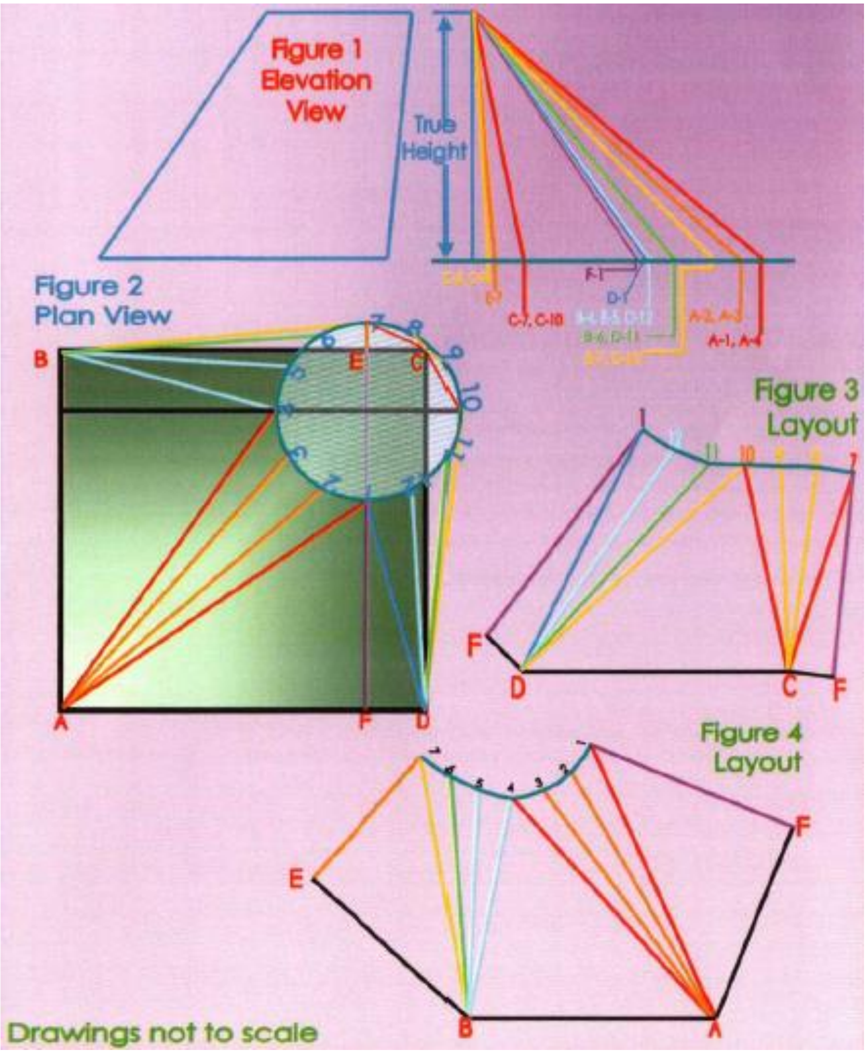
Steps are similar to square to round.



Square to Round with Double Offset, Round Outside the Square

Information Required: Square dimensions, round dimensions, offset dimensions, true height

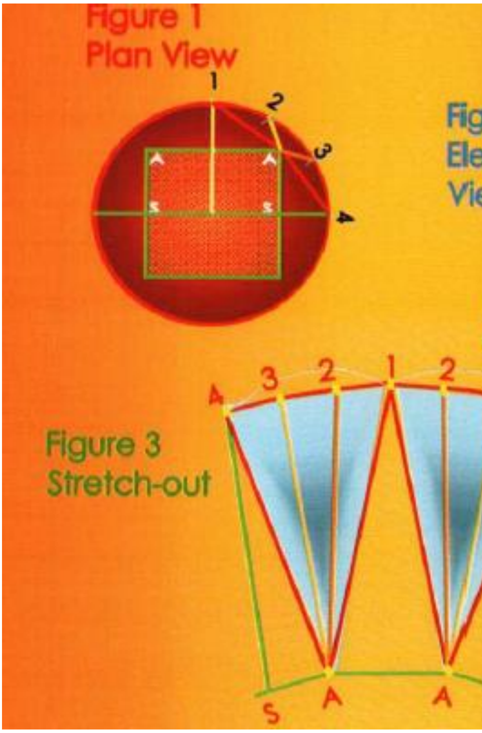
Steps are similar to square to round.



Round to Square

Information Required: True height, square dimensions, round dimensions

Step 1: Draw an elevation view of the fitting (include insulation).
Step 2: Draw plan view. Trisect the top right quarter circle and label as shown.
Step 3: From the plan view, take the measurements from point A to points 1-4.
Step 4: Draw lines from the apex to these points. These lines are the slant heights.
Step 5: For the stretch-out, draw a line the exact length of a square side and label the ends A. From the elevation view set dividers, the apex and points 1-4 on the elevation view. Transfer this length to the stretch-out by using both A points as an apex. Swing arcs, where they intersect is point 1.
Step 6: Set dividers from 1 to 2 on the plan view and swing arcs to each side of point 1 on the stretch-out.
Step 7: From the elevation view, set dividers at the apex and points 2-3 on the elevation view and transfer this measure to the stretch-out again using both A points as an apex. Where these arcs meet is point 2.
Step 8: Use the same methods from steps 6 and 7 to form points 3 and 4.
Step 9: Draw an arc to each side of point A using ½ the measure of a square side.
Step 10: From the elevation view, set the dividers at the apex and point S4 and transfer to the stretch-put using points 4 as the apex points. Where they intersect with the last arc, are the S points.
Step 11: Connect all points to form half of the fitting. Add for lap, crimp and bead.



Rectangle to Rectangle

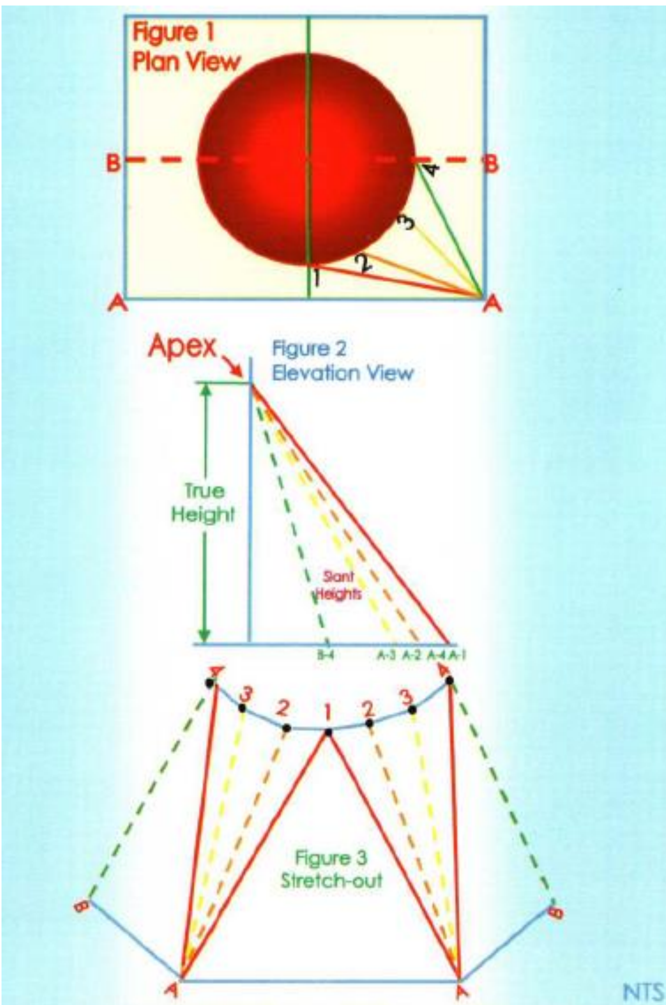
Dims Required: Large and small dims, actual or slant height.

1. Draw the working drawing (end view) include the cross hairs, divide & label (best to include the break lines).
2. Draw the true length triangle and develop the true lengths.
3. Use the dimensions on the working drawing and true length triangle to develop the stretch-out using the triangulation method.

Rectangle to Round

Dims Required: Dimensions of rectangle, OD of round, actual or slant height.

1. Draw the working drawing (end view). Start with cross hairs the circle then rectangle. Label divisions and connect to corners for break lines.
2. Draw the true length triangle and develop the true lengths using the working drawing.
3. Develop the stretch-out using dimensions on the working drawing and true length triangle.



Oval to Round

Information Required: oval dimensions with insulation included, round dimensions, true height

Step 1: Draw a plan view of the fitting.

Step 2: Trisect and label the small circle as shown.

Step 3: Trisect and label the bottom ¼ circles of the oval

Step 4: Draw a 90-degree angle and take the measurements for the slant heights. These measurements are taken from 5 to 1, 1 to 6, 6 to 2, 2 to 7, 7 to 3, 3 to 8 and 8 to 4. Place all these measurements on the horizontal line and label as shown.

Step 5: Start the stretch-out by drawing a horizontal line equal to the distance from 8 to 8 on the plan view.

Step 6: From the slant heights set dividers from the apex to the 8-4 point and transfer to the stretch-out by using point 8 as an apex and swing arcs that will intersect to acquire point 4.

Step 7: From the plan view set dividers from 1 to 2 and on the stretch-out set the dividers on point 4 and swing an arc to each side.

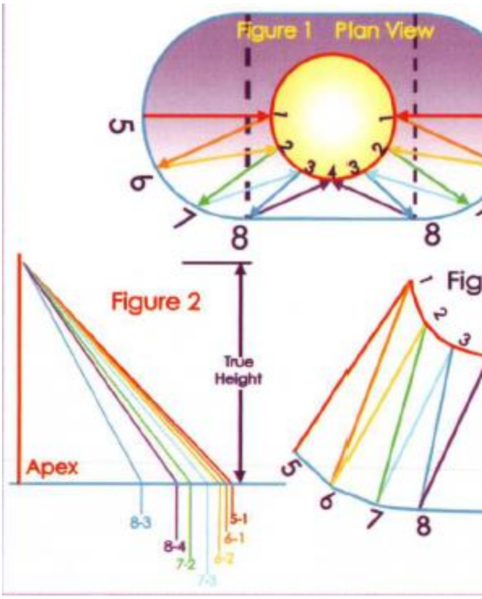
Step 8: Return to the slant heights and set the dividers from the apex to 8-3 point and on the stretch-out, using point 8 as an apex swing intersecting arcs to form point 3 on the stretch-out.

Step 9: From the plan view, set dividers from 7 to 8 and swing arcs to the outside of both points 8.

Step 10: from the slant heights set your dividers at 7-3 point and transfer this measurement to the stretch-out using point 3 as an apex. This arc will intersect to form point 7.

Step 11: continue this formula to obtain all the points for the layout.

Step 12: Connect points, laps and notches to obtain half the layout.



Semi Elliptical Head Segments

Dims Required: OD & OC of head seg width, side & end laps, # of segments, seg length, weld to tangent (tan line).

Seg Width: Divide OC by an even # equally divisible by 4, eg. 40, 44, 48. These would be the number of segs. The resulting math is seg width.

1. Draw the working drawing (side view). Start with a center line then place 1/2 the diameter on each side. Use roughly 1/4 diameter to find the tan line (bottom of where the curve beins).
2. Divide into equally spaced parts and label.
3. Project lines from division marks to the center line and measure.
4. Use the seg width formula to determine the width @ each division. Heel width X R1 –7 ÷ R1

Equal Laterals

Dims Required: OD of pipe (Ins. included)

Working Drawing

Draw the working drawing. Draw center lines, add OD of pipe and scribe arcs on all ends. Divide arcs equally and project lines into drawing and connect.

Tee Portion

Cut a piece of metal equal to the OC + LAP and ÷ into same number of parts as the working drawing and label.

Transfer dimensions from the working drawing to the stretch out.

Body Portion

Cut a piece of metal equal to the OC + LAP ÷ into same number of equal portions as the tee portion. Number according to LAP location.

Transfer points from body portion of the working drawing. #5 goes on line #3, #6 on #2, #7 on #1.

Take all dims from one side of the working drawing.

Unequal Laterals

Required Dims: OD Both pipes, OC both pipes (Ins included).

Working Drawing

Draw the working drawing. Start with the centerline of the large pipe (Top portion not required).

Draw a secondary projection downward form the body portion and divide, carry division lines up to the body portion connecting at the arc, then across and down the pre-divided tee portion.

Tee Portion

Cut a piece of metal equal to the OC of the small pipe + LAP and Divide.

Using dividers transfer small pipe reference points to the stretch-out.

Body Portion

Cut a piece of metal equal to the large OC + LAP

Set dividers to along the large arc that were generated from the secondary projection. Transfer these individual widths into the circ of the metal.

Transfer the dimensions from the body portion of the working drawing. Take all dims from one side. #5 goes on line #3, #6 on #2, and #7 on #1.

Formula for a 45 degree Conical

Information Required: Actual pipe size

Step 1: Draw a 90-degree angle

Step 2: Set dividers at half of the actual OD of the pipe and from the Apex mark both points A on both vertical and horizontal lines

Step 3: Set dividers at half the OD of the insulation and mark points on both vertical and horizontal lines to find point B

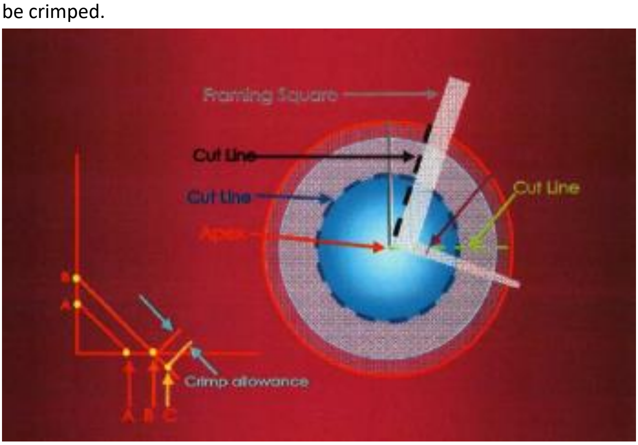
Step 4: Place a straight edge on both B points and at the horizontal line point B. Add crimp measurement to form point C

Step 5: Set dividers at both points A and draw a circle

Step 6: Set dividers at both points B and draw a circle

Step 7: Set dividers at point B on the vertical line and on point C and draw another circle for crimp allowance

Step 8: Set the heel of the framing square at he apex and rotate clockwise until the 1” mark of the framing square intersects the horizontal line. Draw a line from the apex to the outside of the circle. The line just drawn will be a cut line, as well as the horizontal line and the inside circle as well as the outside circle. Now the conical is ready to be crimped.



Another method for a 45-degree conical

Information required: Actual OD of the pipe, actual OD of the insulation .71 weight number.

Step 1: Draw a 90-degree angle. The apex is the point where the lines meet.

Step 2: Multiply the actual OD of the pipe times .71. Take the result to the nearest 16^{th} inch, and from the apex draw a circle.

Step 3: Multiply the OD of the insulation times .71 and with tha tresult to the nearest 16^{th} inch, draw another circle from the apex.

Step 4: Add for desired crimp and draw that circle.

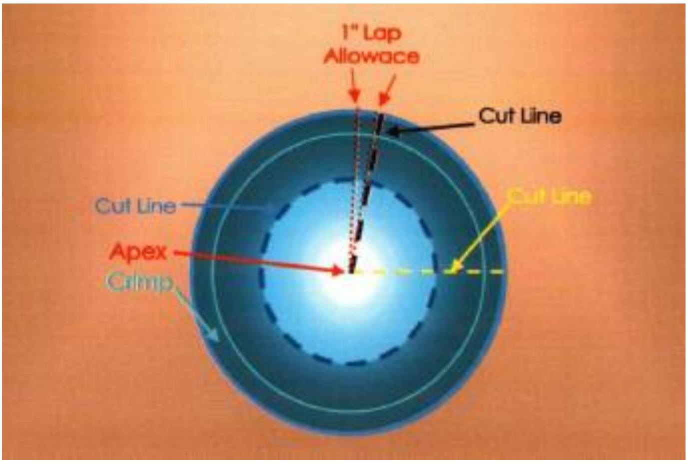
Step 5: Measure 1” to the right of the verticle line and draw a line from that measured point to the apex.

Step 6: Cut lines are the lines obtained in step 5, the outside circle line (Bead and crimp allowance line) and the inner circle line.

Example: 6 X 1 pipe = 6 5/8” actual with insulation 8 5/8”

6.625X0.71=4.7 or 4 11/16”

8.625X0.71=6.12375 or 6 ¼”



Another Method for a 45-Degree Equal Lateral

Information Required: ODI

Step 1: Draw a rectangle using the ODI

Step 2: Draw a semi-circle at each end of the rectangle and trisect both bottom quarters as shown in figure 1.

Step 3: Draw a horizontal line across to each intersecting points of the arcs.

Step 4: Draw a 90-degree vertical line from the base line to the top line. Where the center line and the 90-degree vertical line intersects is point A.

Step 5: Divide the diameter by 5 and set the dividers to that measurement. On the horizontal base line, draw 1 walk-out to the left and 5 walk-outs to the right of the 90-degree vertical center line.

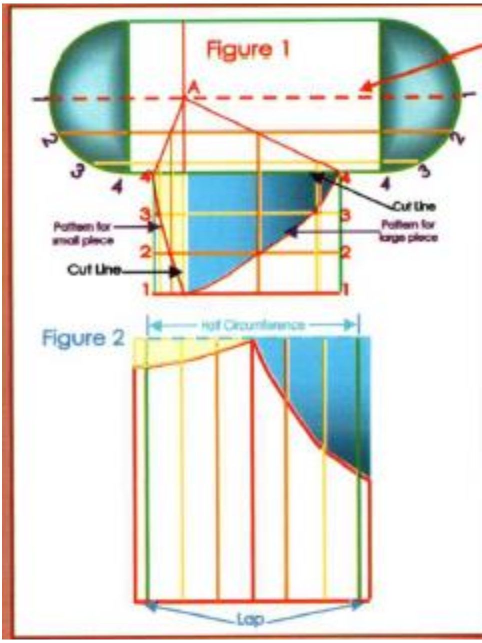
Step 6: Connect walk-out point 1 and walk-out point 5 to point A.

Step 7: Where these lines intersect with the horizontal lines 1, 2, 3 and 4, draw 90-degree lines downward as shown in figure 1.

Step 8: Set dividers at points 1 and 2 on the semi0circle and do a 3-point walk-out down on the lines just drawn in step 7. Draw 90-degree horizontal lines across and label these lines as shown in figure 1.

Step 9: Connect all intersecting points at corresponding numbered lines. The resulting drawing will be half the pattern required for the hole cut-out.

Step 10: For the stem portion of the fitting, lay the pattern on the material as shown in figure 2. Allow for laps and tabs where necessary.



Formula for an Unequal 45-Degree Lateral

Information Required: ODI of both sizes of insulation

Step 1: Draw a horizontal line with a 45-degree line intersecting that line.

Step 2: Draw a 90-degree lines down from each end of the horizontal lines. Also draw a 90-dgree line to the end of the 45-degree line.

Step 3: Using half the ODI of the large insulation, draw a half circle at each end of the horizontal line.

Step 4: Using half the ODI of the smaller insulation draw a semi-circle at the end of the 45-degree line

Step 5: Trisect the small semi-circle into equal parts and draw parallel lines from all trisected points to pints below the horizontal line. Label as in figure 1.

Step 6: Using half the smaller ODI, draw half-circles inside the larger ODI circles of both ends of the drawing.

Step 7: Trisect the half-circles into equal parts and draw lines at 90-degree vertically to points on the large arcs and draw horizontal lines.

Step 8: Draw the lines from the stem portion of the fitting to corresponding numbered lines of the body portion of the fitting and mark the points where they intersect. Connect all of those points.

Step 9: Draw a 90-degree line closer to the body portion of the fitting to establish a measuring line.

Step 10: Divide the circumference by 2 and using the number of divisions of the small semi-circle (in this case 4) do the stretch-out for the stem of the fitting and label as shown in figure 2.

Step 11: Take measurements from the measuring line, to the intersecting points of both body and stem lines and transfer to the corresponding numbered lines on the stretch-out. Connect all these points to obtain half the fitting. Fro the other half add for a lap allowance.

Step 12: For the hole cut-out take half the circumference of the large insulation and draw a measuring line as shown in figure 3.

Step 13: Take the distance between 1-2 on the right side of figure 1 and transfer that distance from the top horizontal line down. Do the same for 2-3 & 3-4.

Step 14: Draw lines to connect corresponding numbered points and label as shown in figure 3.

Step 15: From the measuring line in figure 1 transfer both points 1 to the stretch-out. Do the same for points 2, 3, and 4. Connect all the points to obtain half the body portion of the fitting. For the other half add for laps.

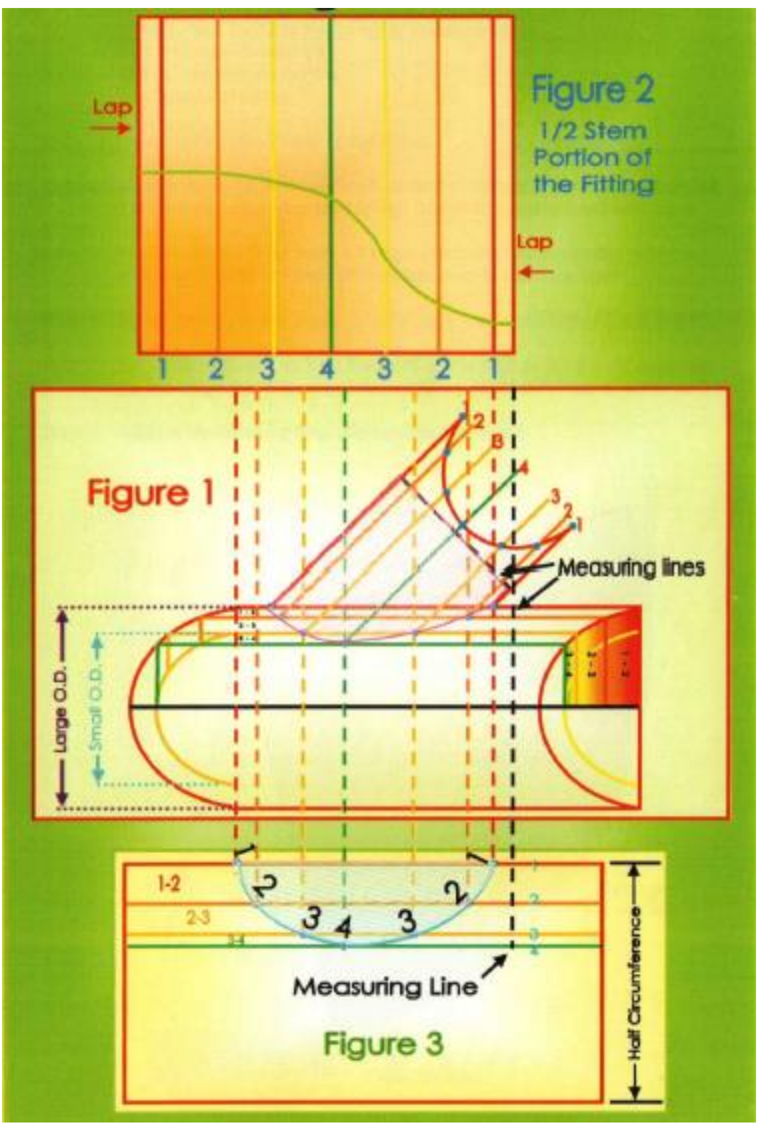


Figure 2
1/2 Stem
Portion of
the Fitting
Lap
Lap
1 2 3 4 3 2 1
Figure 1
Measuring lines
Large O.D.
Small O.D.
1-2
2-3
3-4
Measuring Line
Figure 3
Half Circumference

Concentric Reducer (Equal Cone)

Information Required: Include insulation in measurements, OD of larger insulation, OD of smaller insulation, true height of fitting.

Step 1: Draw an elevation view of the fitting

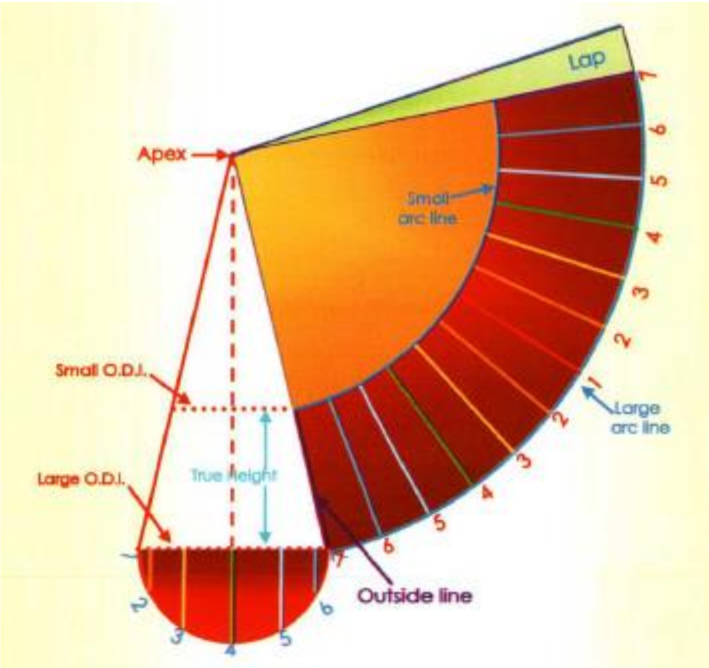
Step 2: Draw a semicircle at the bottom of the elevation view, using half the ODI of the large diameter fitting. Trisect into equal parts and label.

Step 3: Extend the outside lines from the large diameter to the smaller diameter and continue those lines until they intersect to form an apex.

Step 4: Swing arcs from the apex of both the large and small fitting ODI points.

Step 5: Set dividers from 1 to 2 on the semi-circle and do a 13 point walkout on the larger arc (12 for the actual fitting and 1 for the lap allowance).

Step 6: Add for bead and crimp allowances if needed.



Layout for a Cone or Taper

Information required: Large diameter, small diameter, length of fitting

Step 1: Draw a 90-degree angel and where they intersect will be point A.

Step 2: From point A mark half the ODI of the smaller diameter on the horizontal line, this will be point B.

Step 3: Extend a vertical line up from point B

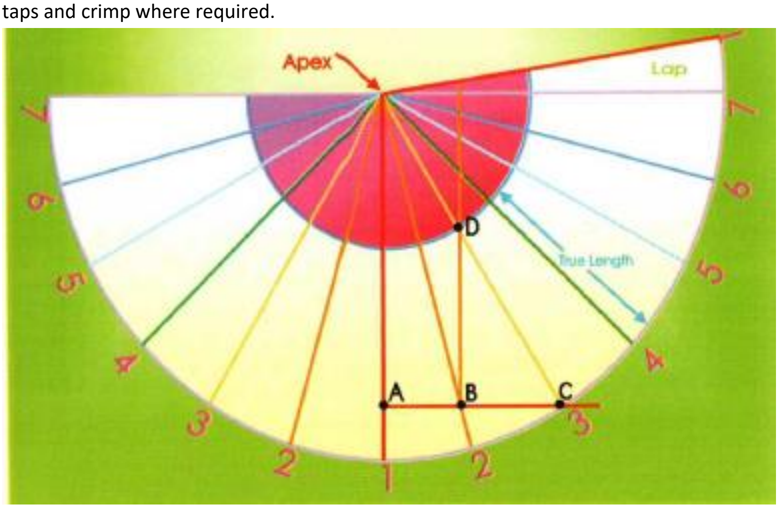
Step 4: From point A mark half the ODI of the larger diameter on the horizontal line. This is point C.

Step 5: With the dividers set at the true length of the fitting, use point C as a temporary apex and swing an intersecting arc on vertical line B to form point D.

Step 6: From point C draw a line through point D to a point on vertical line A to form an apex point.

Step 7: Set the dividers at the apex and point D and swing a large arc, and do the same to point C and the apex.

Step 8: Divide the circumference at the large part of the taper by 12 and draw a 13 point walk out on the large arc (12 for the fitting and 1 for the lap allowance) Add for taps and crimp where required.



Eccentric Reducer or Hognose

Information Required: OD of large insulation, OD of small insulation, length of fitting

Step 1: Draw an elevation view and establish an apex by drawing lines from both outside diameter lines to a point. This point is the apex.

Step 2: Draw a half-circle on top of the elevation, trisect and label.

Step 3: Using pint 1 as a temporary apex, swing arcs from all the numbered points of the semi-circle to points on the horizontal line of the large diameter fitting. Label these points from A-G as shown.

Step 4: Draw lines from these points to the original apex point.

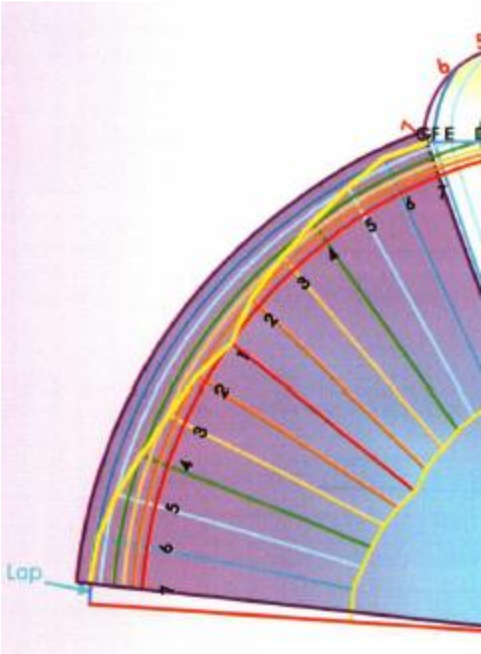
Step 5: Establish point G for the stretch-out and swing arcs from points F, E, D, C, B and A using the original apex as your swing point.

Step 6: Set the dividers from 1 to 2 on the semi-circle and take this set to point G and mark a point on line F. Continue this walkout and step down one letter each time until you reach line A, then step one line at a time until you reach line G.

Step 7: Measure the slant heights of each lettered line and transfer these measurements to the corresponding lettered lines.

Step 8: Connect all the lettered and slant height points to form the fitting.

Step 9: Add for crimp and lap allowance where necessary.



Conic Reducing Tee at 90-Degrees

Information Required: OD of large insulation, OD of small insulation, true height measurement, OD of the insulation where the cone enters the body of the fitting.

Step 1: Draw a vertical line with a 90-degree horizontal line. The vertical line will be the centre line.

Step 2: Draw a circle using half the OD of the large insulation, then measure from the top of the arc to a point on the center line using the true height of the fitting and at this point draw a 90-degree horizontal line.

Step 3: Where the true height point intersects the center line draw a half circle using the ODI of the smallest part of the cone.

Step 4: Trisect the quarter circle on the right side and from points on the arc draw 90 degree lines to the smaller diameter line. Number these points on the diameter line as shown.

Step 5: Draw a 90-degree horizontal line from the top of the circle and measure half the width of the conic as it enters the body of the fitting as shown in figure 2. Transfer this measurement from the center line to the right on the line you have just drawn.

Step 6: From the point determined in step 5 to the OD of the smaller arc, draw a line to form an apex on the vertical line and an intersecting point on the larger arc. Mark this line A.

Step 7: From the apex just formed, draw lines through points 2 and 3 on the horizontal line of the small arc to intersecting points on the large arc.

Step 8: At these intersecting points on the large arc, draw 90 degree lines out to line A and label as shown.

Step 9: For the stretch-out set the dividers at the apex and point 4 on the small arc and swing an arc, this arc will be line 4.

Step 10: Set the dividers at points 1 and 2 on the small arc and transfer 13 walkout points to line 4 (12 for the fitting and 1 for the lap allowance).

Step 11: Set the dividers at the apex and point A in figure 2 and swing another arc. This will be arc line A.

Step 12: From the apex to walkout points on the line 4, draw lines through to points on arc line A, label as shown in figure 3.

Step 13: Take a measurement from A to B on the outside line that runs from the apex to the large arc in figure 2 and transfer this measurement to all B lines on the stretch out. Draw the same points C &D, but take all of the measurements from point A.

Step 14: Connect all the points and allow for laps, tabs and bead.

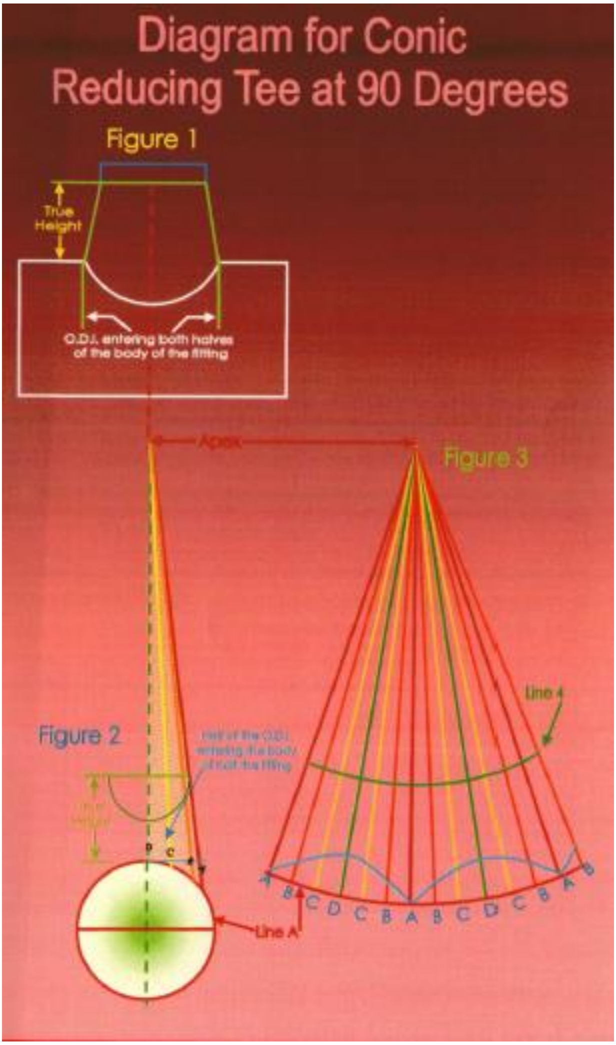


Diagram for Conic
Reducing Tee at 90 Degrees
Figure 1
True
Height
O.D.I. entering both halves
of the body of the fitting
Apex
Figure 3
Figure 2
Line A
A B C D C B A B C D C B A B

EXTRUDED FOAM RUBBER

Extruded Foam Elbows

On a square corner of the material (90°) . Scribe an arc representing the mean radius of the elbow.

Subtract 1/2 the OD of the pipe (including wall thickness) from the mean radius then mark R1

Add 1/2 the OC Insulation included to R1 then put 1 tip of the divider on the apex and scribe R2

Cut out and use as a pattern.

Note: A chart may be used to get the dimensions required to layout an elbow.

Long Radius Rubber 90 Degree Elbow

Information Required: Pipe call-out size, thickness of insulation

Step 1: Draw a 90 degree angle from the apex swing an arc using the pipe call out size times 1 1/2 . This is the center radius line.

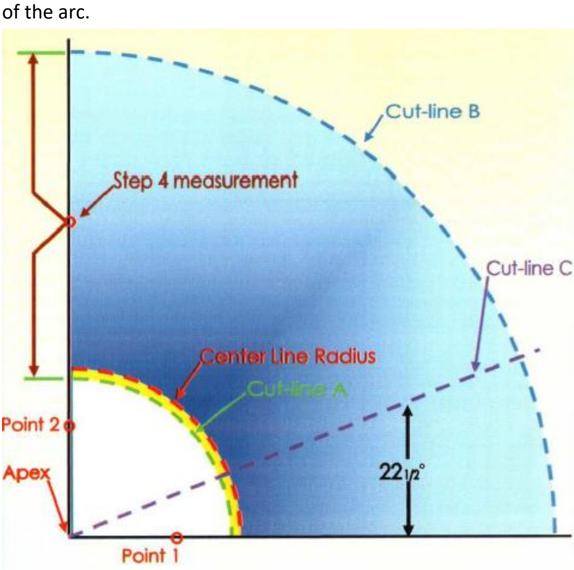
Step 2: Divide the pipe call-out size by 2 and measure from the center line radios towards the apex, both vertically and horizontally to create points 1&2 and label them.

Step 3: Set dividers at points 1 & 2 and swing an arc from the apex to form cutline A.

Step 4: Multiply the pipe call-out size by Pi, dive by 2 and add 1 ½. Use this measurement to park a point on the vertical line from cut line A.

Step 5: Set dividers at the apex to this point and swing an arc to the horizontal line to form cut line B.

Step 6: Cut line C is created by drawing a 22 ½ degree line from the apex to the outside of the arc.



Short Radius Rubber 90 Degree Elbow

Information Required: Pipe call-out size

Step 1: Draw a 90-degree angle.

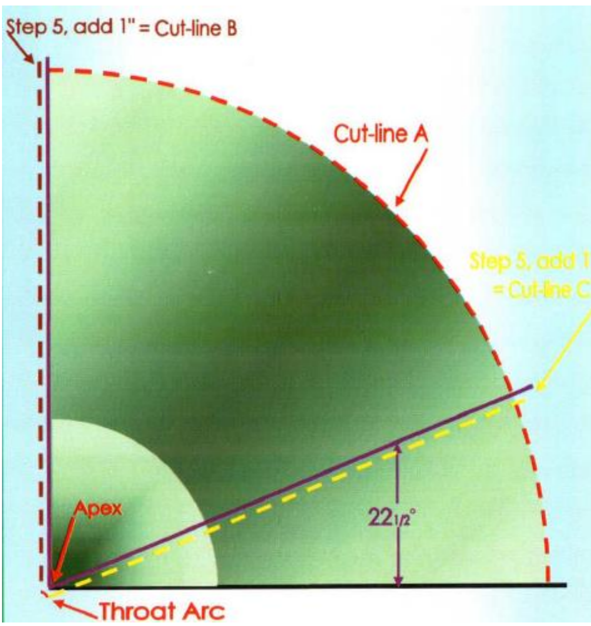
Step 2: Multiply the pipe callout size by pi, divide by 2 and add 1 ½.

Step 3: Swing an arch from the apex. Use this measurement to form cut line A.

Step 4: Draw a 22 ½ degree line from the apex to cutline A form the horizontal line

Step 5: Add 1” to both the vertical and the 22 ½ degree lines to form cut lines B&C.

Step 6: Swing an arc for the throat.



Equal Reducing Rubber 90 Degree Elbow

Information Required: Small Pipe Diameter, Large Pipe Diameter, Insulation Thickness

Step 1: Draw a 90-degree angle

Step 2: Square the fittin from weld to weld using a framing square. Using that measurement, swing an arc to form cut-line A.

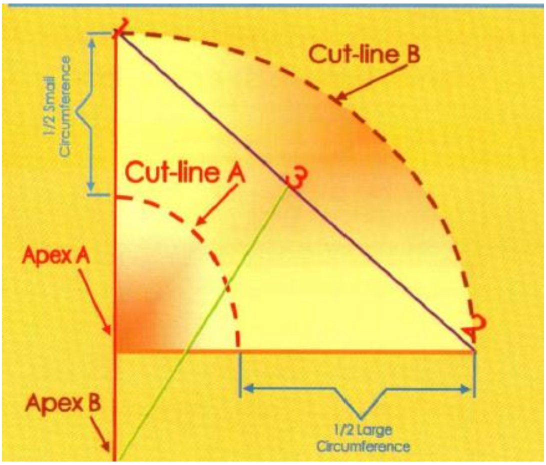
Step 3: Multiply the OD of the small pipe (insulation included) by Pi and then divide by 2 and add one inch. Mark this easy recent on the vertical line using cut-line A as a starting point. Label this point 1.

Step 4: Multiply the OD of the large pipe (insulation included) by Pi and then divide by 2, and then add one inch. Mark this measurement on the horizontal line using cut-line A as a starting point. Label this point 2.

Step 5: Draw a line from point 1 to point 2 and divide that line into 2 equal parts. Label the division point 3.

Step 6: At point 3 draw a 0- degree line perpendicular to line 1-2 to an interesting point on the extended vertical line. This point is Apex B.

Step 7: Set dividers from the apex B point to number 1 and draw an arc to number 2 to form cut-line B.



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Concentric Extruded Foam Rubber Reducer

1. Cut a piece equal to the large OC (Insulation included) & the actual height + 2 working edges.
2. Divide into 4 equal parts & put a working edge on the top & bottom.
3. Subtract the small OC from the large OC & **divide by 4.**
4. Place 1/2 the dimension on each side of the 1/4 points.
5. Mark lines from the above dimensions to the 1/4 points they span.
6. Cut out and glue together.

Eccentric Extruded Foam Rubber Reducer

1. Cut a piece equal to the large OC (Insulation included) & the actual height + 2 working edges.
2. Divide into 4 equal parts & put a working edge on the top & bottom.
3. Subtract the small OC from the large OC & **divide by 3.**
4. Place 1/2 the dimension on the side of 4 of the 4 1/4 points.
5. Mark lines from the above dimensions to the 1/4 points they span.
6. Cut out and glue together

MEASUREMENTS

MEASURING COMPLETED INSULATION METHOD A

Applicable where contractor has quoted unit rate per linear metre of straight pipe and per each for pipefitting.

STRAIGHT PIPE

Shall be measured from origin to terminus point or junction, along the centerline of pipe. Measurements shall be through valves, flanges and fittings, but only if the valves, flanges and fittings are insulated. Elbows or bends shall be measured through to the intersection of the centre lines of the pipe. Reducers shall be counted as one fitting of the larger size involved, and omitted from the count of the smaller size. Tees shall be counted as one fitting, and if an unequal tee, shall be counted as a fitting of the smaller size. Quantities shall be to the nearest whole number (0.51 and larger to the whole number above).

FITTINGS-VALVES

Shall be counted per each. (Flanges on flanged valves shall be counted separately).

FLANGES

Shall be counted per pair of flanges. (Including flanges on valves and connections to vessels and equipment).

MEASURING COMPLETED INSULATION METHOD B

Applicable where the contract has quoted unit rate per square metre of completed insulation. Areas of completed insulation will be measured as defined in attached schedule. Should there be any items not detailed, the client and the contractor are to agree a system of measurement in advance.

Notes:

All external insulation is measured over the outer surface area of the completed insulation. All internal insulation is measured over the surface area, which has been insulated. The method establishes actual areas of insulation, and makes no extra over allowance for difficulty of work as regards formwork or height. Should the contractor wish to charge an increased rate for difficult work he should specify to which items the quoted increased rate will apply. Quantities shall be calculated to the nearest whole number (0.51 and larger to the whole number above).

GENERAL

Cut-outs under $1.0m^{2}$ are not deducted. End cap areas are measured to establish the actual surface area of insulation. Cut outs in such areas are treated as follows:

a) If gross area of end cap is less than $1.0m^2$ cut-outs are not deducted.

b) If gross area of end cap is $1.0m^2$ or greater, deduct cut-outs, but subject to rule above.

c) Pockets, niches, flattening shall be measured as if the cladding remains symmetrical.

MEASURING COMPLETED INSULATION METHOD A

Applicable where contractor has quoted unit rate per linear metre of straight pipe and per each for pipefitting.

STRAIGHT PIPE

Shall be measured from origin to terminus point or junction, along the centerline of pipe. Measurements shall be through valves, flanges and fittings, but only if the valves, flanges and fittings are insulated. Elbows or bends shall be measured through to the intersection of the centre lines of the pipe. Reducers shall be counted as one fitting of the larger size involved, and omitted from the count of the smaller size. Tees shall be counted as one fitting, and if an unequal tee, shall be counted as a fitting of the smaller size. Quantities shall be to the nearest whole number (0.51 and larger to the whole number above).

FITTINGS - VALVES

Shall be counted per each. (Flanges on flanged valves shall be counted separately).

FLANGES

Shall be counted per pair of flanges. (Including flanges on valves and connections to vessels and equipment).

MEASURING COMPLETED INSULATION METHOD B

Applicable where the contract has quoted unit rate per square metre of completed insulation. Areas of completed insulation will be measured as defined in attached schedule. Should there be any items not detailed, the client and the contractor are to agree a system of measurement in advance.

Notes:

All external insulation is measured over the outer surface area of the completed insulation. All internal insulation is measured over the surface area, which has been insulated. The method establishes actual areas of insulation, and makes no extra over allowance for difficulty of work as regards formwork or height. Should the contractor wish to charge an increased rate for difficult work he should specify to which items the quoted increased rate will apply. Quantities shall be calculated to the nearest whole number (0.51 and larger to the whole number above).

GENERAL

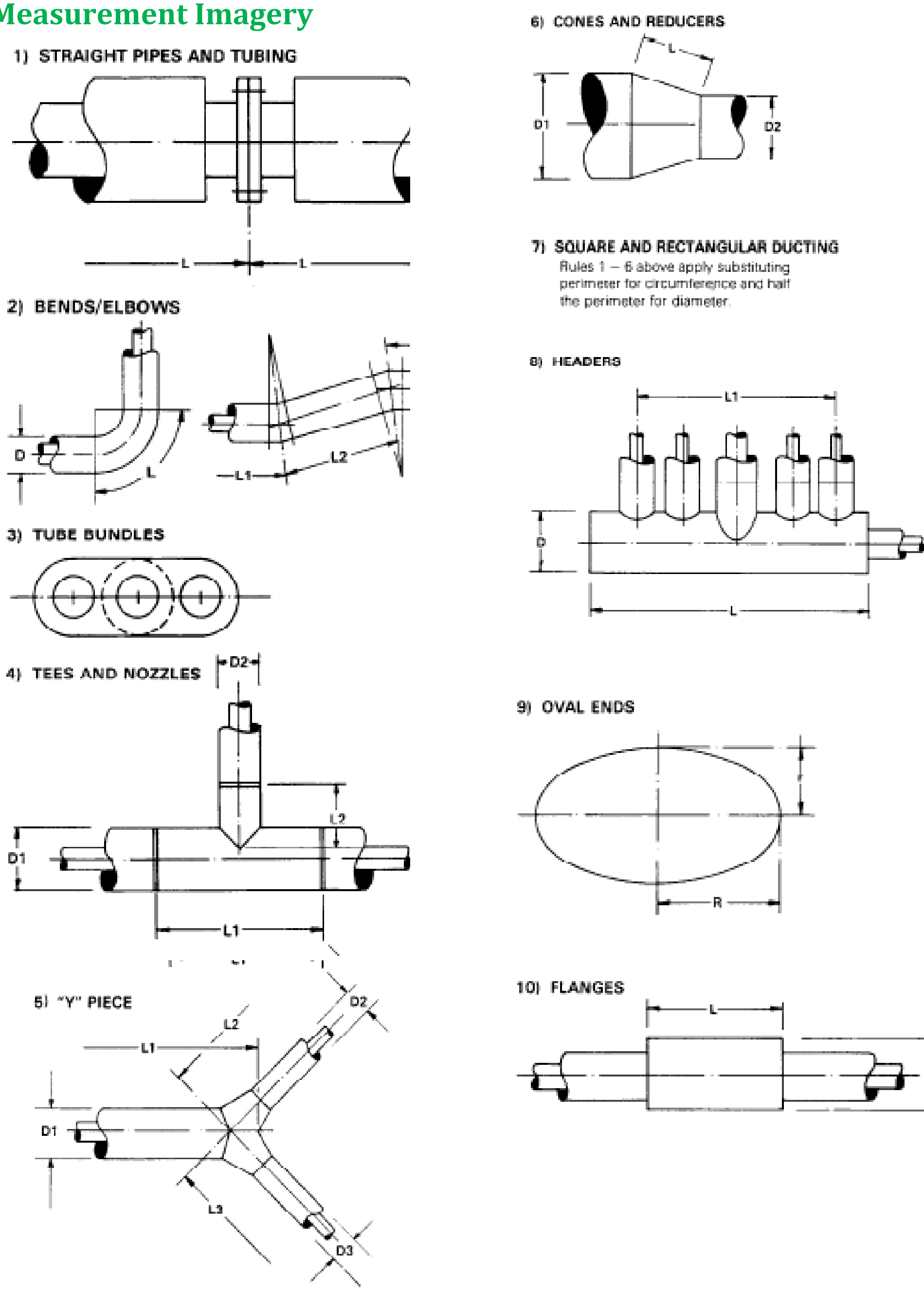
Cut-outs under 1.0m^2 are not deducted. End cap areas are measured to establish the actual surface area of insulation. Cut outs in such areas are treated as follows:

a) If gross area of end cap is less than 1,0m^2 cut-outs are not deducted.

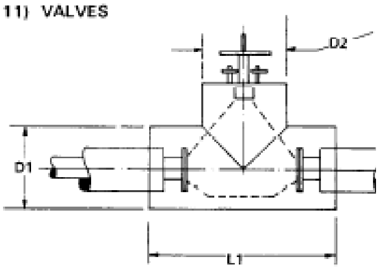
b) If gross area of end cap is 1,0m^2 or greater, deduct cut-outs, but subject to rule (a) above.

c) Pockets, niches, flattening shall be measured as if the cladding remains symmetrical.

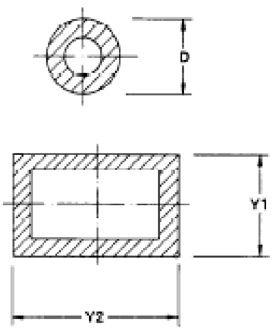
Measurement Imagery



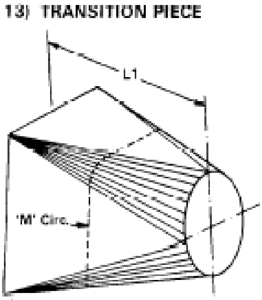
11) VALVES



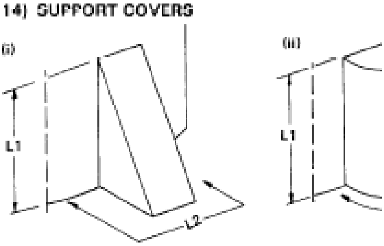
12) INTERNAL INSULATION



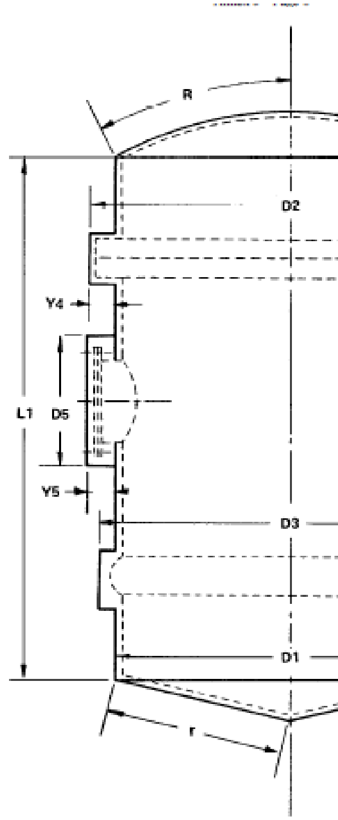
13) TRANSITION PIECE



14) SUPPORT COVERS



15) VESSELS



Areas of:

Main body = D1 x L1 x π
Dished topes = π R^2
Cronical bottom = D1 x π x $\frac{r}{2}$

Box over expansion bellows = (2Y2 + Y1) x D3 x π
Box over flange / stiffener = (2Y4 + Y3) x D2 x π
Small body = D4 x π x L4
Manhole cover = (π x $\frac{D5^2}{4}$) + (π x D5 x Y5)

Gores to A Domed Head

Information Required: Height of domed head (from weld to tank top) and radius of the tank.

Step 1: Draw a horizontal line the exact length of the radius of the tank and the rise combined. Draw a 90-degree vertical line the exact length of the radius of the tank and rise combined. The two lines intersect as shown in the drawing.

Step 2: Draw a quarter circle in the top left area using the rise as the radius. Draw a quarter circle in the bottom right area using the radius of the tank.

Step 3: Divide the bottom right quarter circle into 12 equal parts and from these points set a straight edge that intersects the apex to points on the small quarter circle. Mark all 11 points on the small quarter circle.

Step 4: Draw 90-degree vertical lines up from every point on the large quarter circle as shown.

Step 5: Draw 90-degree horizontal lines from every point on the small quarter circle as shown.

Step 6: Label all points on both quarter circles as shown.

Step 7: Where lines 2 intersect, mark with a dot. Do the same for lines 3-12.

Step 8: Connect all the dots to from the tank top curve.

Step 9: Determine the gore width by trial and error method, then draw half the gore width on the vertical line 12 and from that point draw a line to the Apex.

Step 10: Add a ½” bead and crimp allowance tot eh initial horizontal line. Draw the stretch-out the regular way.