



**A Standard Method
of Measuring Quantity
for Industrial Insulation**

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STANDARD METHOD OF MEASUREMENT

These standards will be used for the express purpose of measuring the quantities of insulation required for a mechanical system. They will be used for tendering, evaluation of bids, and for finalizing accounts.

1. SCOPE

Insulation of mechanical systems including, but not limited to, vessels, tanks, exchangers, pumps, pipework, equipment and ducts.

2. All measurements shall be taken on the external surface of the insulation system.
3. There shall be no deductions for surfaces not insulated within the insulation area.
4. All insulated obstructions and penetrations shall be measured separately.

DEFINITIONS

Types of insulation: Hot and Cold Thermal, Acoustic, Fireproofing.

Class of items to be insulated:

(a) Vessels

Containers, Storage Tanks, Columns, Drums, etc.

(b) Equipment

Machinery which has an irregular outer surface, e.g. turbines, pumps, compressors, etc.

(c) Flat Surfaces

Boiler walls, duct insulation, precipitators, etc.

(d) Piping

Straight pipes, bends, elbows, accessories, fittings, valves, flanges, etc.

(e) Instruments

Measuring and controlling devices for process requirements.

(f) Height Allowances

Standards.

PRINCIPALS OF MEASURING

Shell - Cylindrical

The outside diameter of the vessel plus two times the insulation thickness multiplied by 3.14 and by the length tangent line to tangent line as illustrated in diagram. Transition sections (changes in diameter) shall be measured using the larger diameter. There shall be no deductions for manholes and any other interruption or projection, whether insulated or not.

Irregular Surfaces

Any irregular shape shall be measured on the outside of the insulation surface, using the largest diameter. For small pumps, turbines, etc. the minimum area of measurement shall be 5 sq. feet.

Heads, Roofs, Ends

Flat: The surface area with diameter outside of the vessel insulation.

Spherical: The surface area of the hemisphere with diameter outside of the vessel insulation.

Heads, Roofs, Ends (continued)

Dished: The surface area of a flat circle with a diameter outside of the vessel insulation, multiplied by a correction factor of 1.37.

Cones: The geometrical surface of the cone, measured outside the insulation thickness.

SPECIAL NOTE

On "Unit Price" contracts, all nozzles connecting to a vessel will be measured as pipe run to the vessel wall plus flange. All brackets, platform supports and other obstructions shall be measured as pipe of an equivalent outside diameter, up to the transition joint in the support. For cold insulation, multiply by a correction factor of 2.0. Where like obstructions, brackets, stiffening rings, etc. have not been shown in detail on bid drawings for a lump sum contract, they shall be measured as extra work as above.

Piping

Straight pipe shall be measured from centre line to centre line through all fittings.

Bends and elbows shall be measured on the outside radius. All fittings will be counted and classified for multiplication by the appropriate factor shown on the "Fitting Factor Table" contained herein. All piping shall be measured in accordance with Diagram "A". All fittings that connect two or more different sizes of pipe shall be counted as part of the largest size involved.

CONVERSION TABLES FOR FITTINGS TO BE ADDED TO
LINE TOTAL MEASURED THROUGH ALL FITTINGS

45° Elbows

½" to 2½" pipe	1.5 lin. ft. of same size and thickness
3" to 5" pipe	2 "
6" to 8" pipe	2.5 "
9" to 12" pipe	3 "
14" to 24" pipe	4 "
25" to 30" pipe	5 "

90° Elbows

½" to 2½" pipe	2 lin. ft. of same size and thickness
3" to 5" pipe	3 "
6" to 8" pipe	4 "
9" to 12" pipe	5 "
14" to 24" pipe	6 "
25" to 30" pipe	7 "

Flanges (pair) - hot	3 lin. ft. of same size and thickness
- cold	7 "

Valve Body (Screwed)	2 lin. ft. of same size and thickness
Valve Body (Flanged)	2 " (flanges excluded)
Valve Body (Weld)	3 "

Bent Pipe	3 lin. ft. of same size and thickness
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CONVERSION TABLES FOR FITTINGS TO BE ADDED TO
LINE TOTAL MEASURED THROUGH ALL FITTINGS

Tees	2	lin. ft. of same size and thickness
Reducers, Caps and Termination Points	1.5	lin. ft. of same size and thickness
*Hangers Hot	1	lin. ft. of same size and thickness
Hangers Cold	2	"

* Includes shoe supports and brackets. Excludes guides and anchors.

For removable fittings covers multiply factors by 2.

Allowance for screwed fitting:

Flexible insulation - none

Preformed or rigid insulation - 3 lin. ft. per fitting

Metric Measurement (Conversion)

For equivalent fitting factors multiply computations by .31

HEIGHT ALLOWANCES

Height Factor Above Grade or Working Floor Level

Factor to increase unit price for over 10' 0" height by 10%.

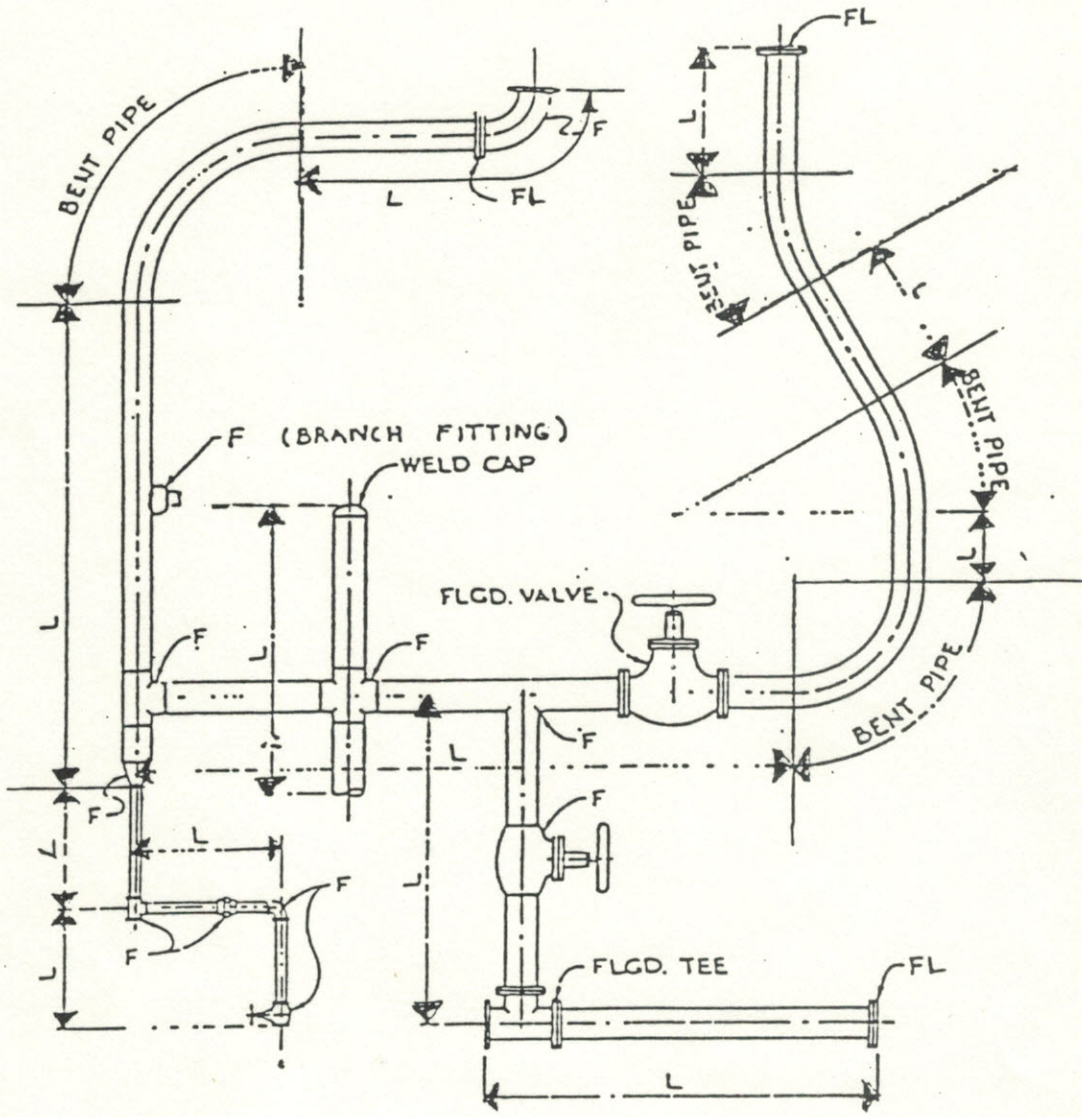
Factor to increase unit price for over 20' 0" height by 20%.

Factor to increase unit price for over 30' 0" height by 30%.

Factor to increase unit price for over 40' 0" height by 40%.

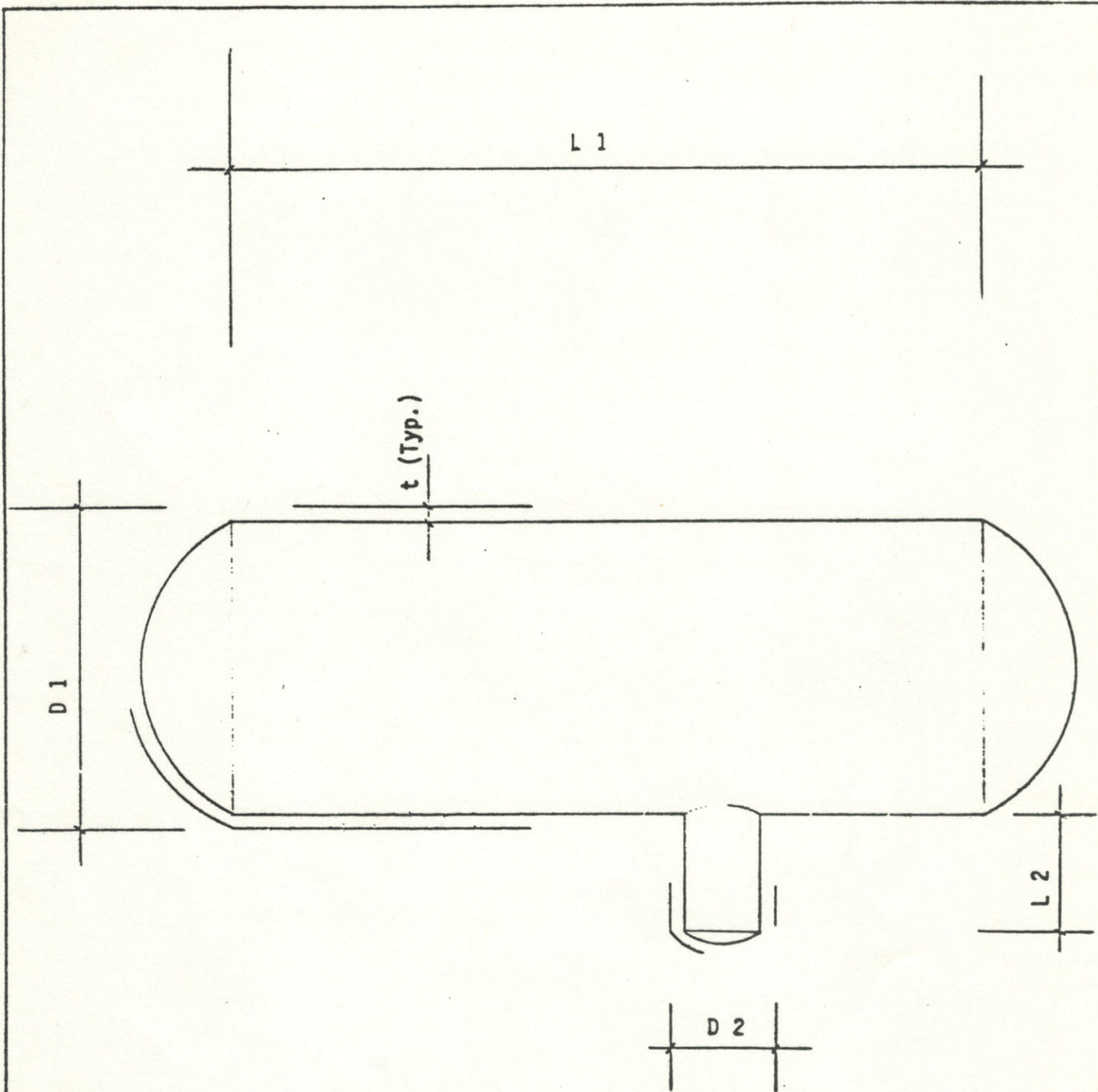
Factor to increase unit price for over 50' 0" height by 50%.

Factor to increase unit price for over 60' 0" height by 60% and 1% per
additional foot.



- L Linear Footage
- F Fittings
- FL Pair of Flanges

DIAGRAM "A"
METHOD OF MEASUREMENT
 Typical Piping Arrangement



D1, D2

Effective Diameters

L1, L2

Tan to Tan Lengths

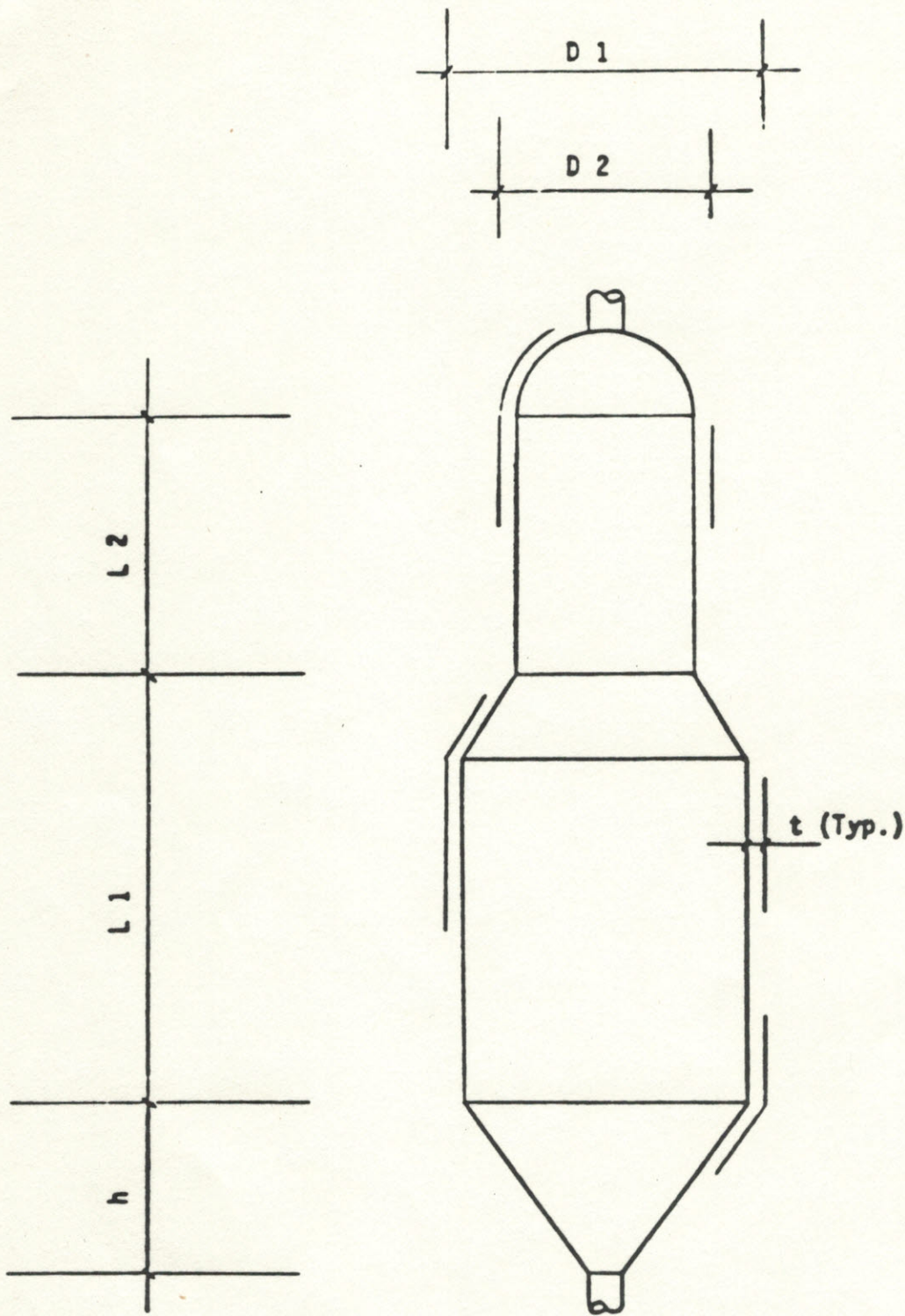
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Insulation Thickness

DIAGRAM "B"

METHOD OF MEASUREMENT

Typical Dished Head Drum with Boot



$D1, D2$

Effective Diameters

$L1, L2$

Respective Lengths

h

Height of Conical Head

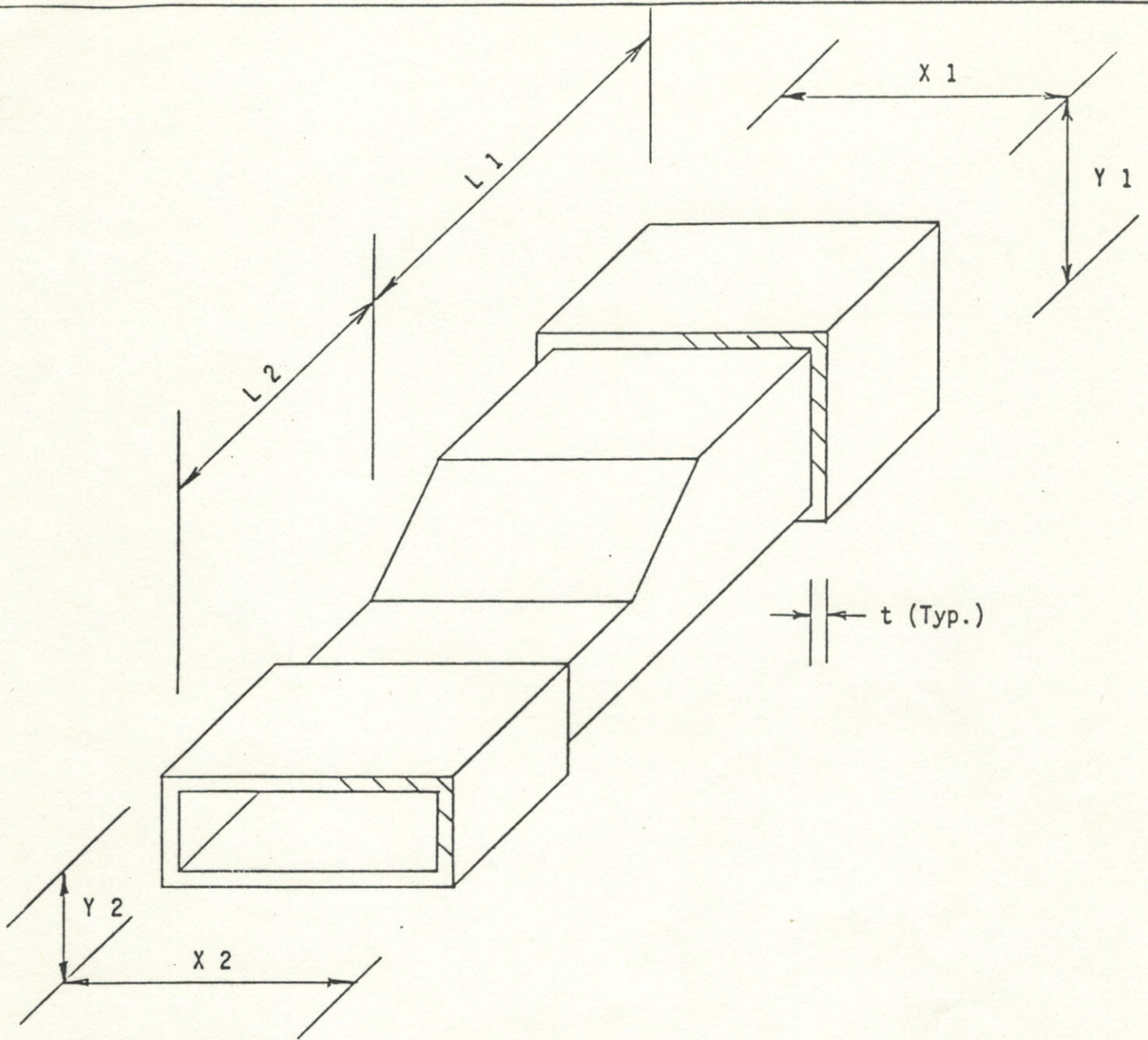
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Insulation Thickness

DIAGRAM "C"

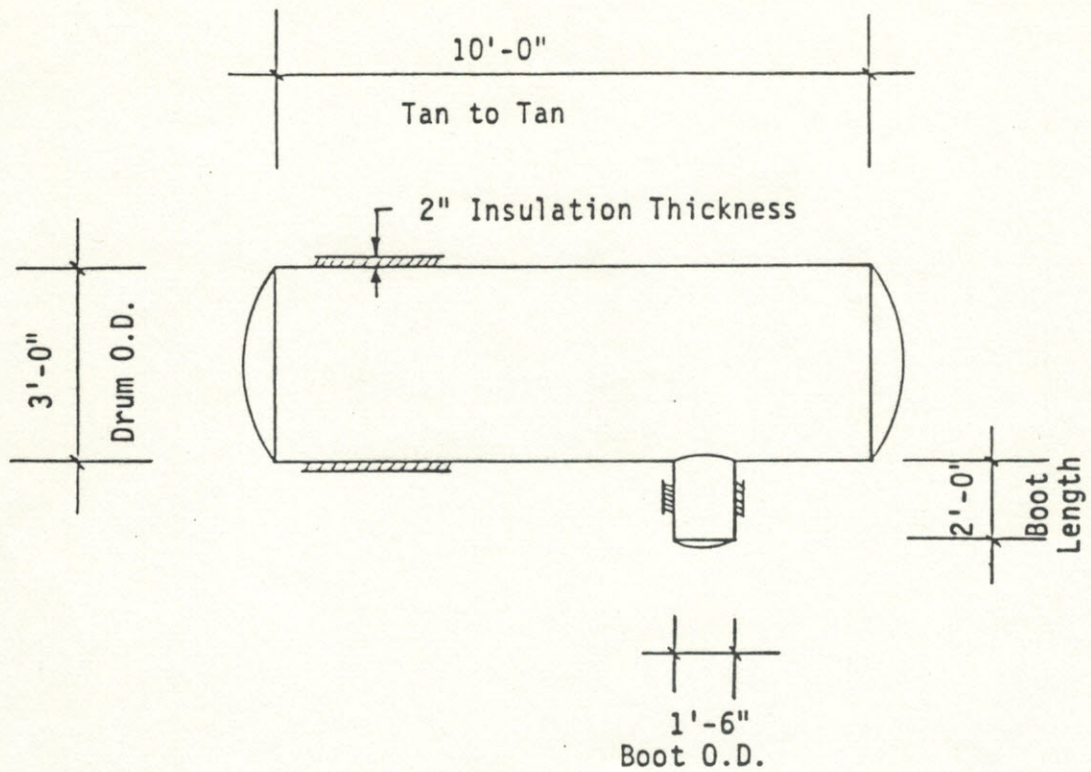
METHOD OF MEASUREMENT

Vertical Vessel with Transition
Piece, Spherical and Conical Heads



X_1, Y_1, X_2, Y_2 Effective Duct Dimensions
 L_1, L_2 Respective Duct Lengths
 t Insulation Thickness

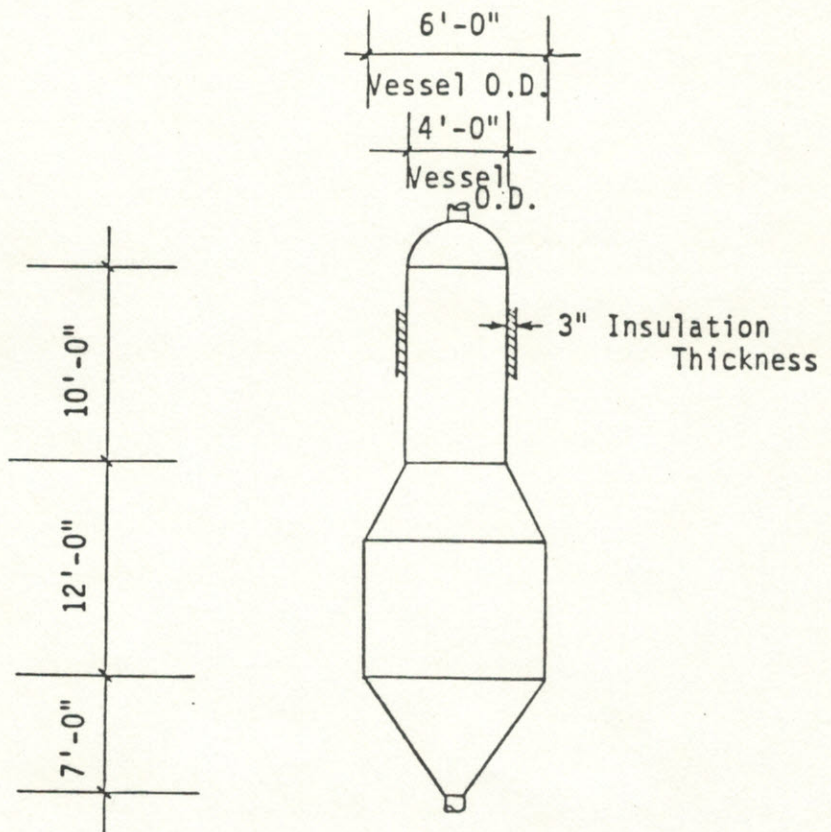
DIAGRAM "D"
METHOD OF MEASUREMENT
 Typical Duct Section With
 Transition Piece



$$\begin{aligned}
 \text{Total Shell Area} &= (3.33 \times 3.14 \times 10) + (1.83 \times 3.14 \times 2) \\
 &= 104.56 + 11.49 \\
 &= \underline{116.05 \text{ sq.ft.}}
 \end{aligned}$$

$$\begin{aligned}
 \text{Total Heads Area} &= [(3.33 \times 3.33 \times 3.14 \times 2 + 4) + (1.83 \times 1.83 \times 3.14 + 4)] \times 1.37 \\
 &= (17.41 + 2.63) \times 1.37 \\
 &= \underline{27.45 \text{ sq.ft.}}
 \end{aligned}$$

DIAGRAM "E"
EXAMPLE OF MEASUREMENT
 Typical Dished Head Drum with Boot



$$\begin{aligned}
 \text{Total Shell Area} &= (4.5 \times 3.14 \times 10) + (6.5 \times 3.14 \times 12) \\
 &= 141.3 + 244.92 \\
 &= \underline{386.22 \text{ sq.ft.}}
 \end{aligned}$$

$$\begin{aligned}
 \text{Top Spherical Head Area} &= 3.14 \times 4.5 \times 4.5 + 2 \\
 &= \underline{31.79 \text{ sq.ft.}}
 \end{aligned}$$

$$\begin{aligned}
 \text{Bottom Conical Head Area} &= (3.14 \times 6.5 + 2) \times \sqrt{(3.25 \times 3.25) + (7 \times 7)} \\
 &= 10.21 \times 7.72 \\
 &= \underline{78.82 \text{ sq.ft.}}
 \end{aligned}$$

DIAGRAM "F"

EXAMPLE OF MEASUREMENT

Vertical Vessel with Transition
Piece, Spherical and Conical Heads

DIAGRAM "G"

EXAMPLE OF PIPING MEASUREMENTS

<u>Pipe Size</u>	<u>Spec.</u>	<u>Length of Pipe</u>	<u>Bent Pipe</u>	<u>45° Elbows</u>	<u>90° Elbows</u>	<u>Flanges (pair)</u>	<u>Valve Bodies</u>	<u>Tees</u>	<u>Reducers or Caps</u>	<u>Hangers</u>	<u>Screwed Fittings</u>	<u>Equivalent Footage</u>
1"	Hot	108 ft.	-	-	16	-	-	6	3	-	13	195.5 lin. ft.
3"	Cold	78 ft.	-	2	8	3	1	-	-	3	1	135.0 lin. ft.
8"	Hot	200 ft.	26 ft.	-	7	8	2	3	1	7	-	348.5 lin. ft.
30"	Hot	302 ft.	-	4	3	-	1	7	1	12	-	372.5 lin. ft.