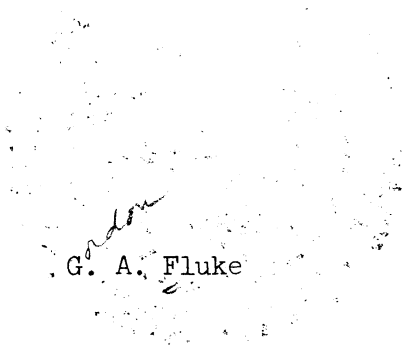
THE UNIVERSITY OF MICHIGAN

INDUSTRY PROGRAM OF THE COLLEGE OF ENGINEERING

# THERMAL INSULATION FOR PIPING AND EQUIPMENT

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# PREFACE

This specification has been prepared as a guide for persons writing contract documents for construction of new facilities or alterations to existing facilities that include thermal insulation. It is intended that applicable sections may be extracted as written since it is not probable that any plant will experience a simultaneous need for all classes of insulation included.

Where plant standards do not exist this specification may be used as a standardization basis. Where plant practices have been established over limited temperature ranges, this specification can be used to develop a more inclusive standard. Where sections of this specification differ from established plant practices the local engineering group will, of course make the choice as to which will govern.

The material herein covers thermal insulation for refrigerated and heated piping and equipment, that is, -30°F to +600°F. In addition to establishing the materials, the specification covers the required efficiency of insulation, methods of computing charges, auxiliary materials, application and finishes, and includes typical installation sketches.

ACKNOWLEDGEMENT

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLES

STANDARD THERMAL INSULATION

APPENDIX B FIGURES

FIGURES (CONT'D)

## SECTION A

## SELECTION AND THICKNESS

1.0 INTENT

1.1 This section is intended to establish the proper material and efficiency required for various pipe lines and equipment. Refer to Section E, Finishes, for selection and description of finish.

1.2 The insulating materials together with their code numbers and uses are tabulated below

| Temperature °F | Code No. |
|---|---|
| 212 to 600 | 1A, 1B & 1C |
| 212 to 300 | 2A |
| 212 to 1000 | 4 |
| -15 to 70 | 6A, 6B & 6C |
| Anti-sweat | 7A & 7B |
| Anti-freeze | 8A & 8B |
| Fill | 9A & 9B |

2.0 CLASS 1 INSULATION

85% Magnesia - Code 1A

Spun Glass - Code 1B

Felted Laminated Asbestos - Code 1C

2.1 These materials are for use on pipe lines or equipment operated at temperatures from 212°F to 600°F. At temperatures from 212°F 300°F, Corrugated Asbestos, that is, Class 2, may be used for inside building heating lines and other intermittent or seasonally operated applications.

2.2 Magnesia shall not be used on stainless steel pipe where chlorine or chlorides are present either in the form of fluid or gas handled in the pipe or present in the atmosphere surrounding the pipe. Investigation has shown that magnesium chloride formed by the combination of magnesia and chlorine has produced cracking of stainless steel pipe. Also magnesia shall not be used on aluminum, zinc, or lead because of corrosive effects. Spun Glass is satisfactory for such applications.

2.3 Asbestos products shall not be used on aluminum, zinc, or lead.

3.0 CLASS 2 INSULATION

Corrugated Asbestos - Code 2A

3.1 Corrugated asbestos is for use on hot-water lines to prevent burns to personnel or to reduce heat loss when required, and on indoor building heating lines and other seasonal, intermittently operated indoor applications where temperatures are between 70°F and 300°F. Where resistance to mechanical damage is required, materials listed above, particularly Code 1B and 1C may be specified. Corrugated asbestos with Type C finish is recommended for experimental and temporary lines because of its low cost.

4.0 BLANKET INSULATION

Mineral Wool Blanket - Code 4A

4.1 This material is recommended for use on large equipment such as turbines and breechings where temperatures range up to 1000°F.

5.0 LOW-TEMPERATURE INSULATION

Vegetable Cork - Code 6A

Impregnated Mineral Wool - Code 6B

Mineral Wool Felt - Code 6C

5.1 These materials are for use on refrigerated lines. Preformed cork or preformed impregnated mineral wool is used for pipe lines and wool felt is used on valves, fittings, and equipment.

6.0 ANTI-SWEAT INSULATION

Ground Cork and Asphalt - Code 7A

Insulating Felt - Code 7B

6.1 These materials are used to prevent sweating and resultant dripping from moisture condensation on cold lines.

6.2 Ground cork and asphalt (Code 7A) is not for use where sweating would be objectionable if conditions are more severe than would exist with 55°F equipment temperature and 65% relative humidity at 70°F air temperature.

6.3 Code 7A shall be applied as a 1/4-inch coating on 5-inch and larger pipes and requires no finish.

6.4 Code 7A cannot be applied conveniently on small lines; therefore, Code 7B (1-inch thick) is used on pipe lines up to 5-inches. Code 7B is furnished with integral jacket which is peeled back to permit wiring insulation in place and then pasted down as Type A finish. Normally, no other finish is required.

.0 ANTI-FREEZE INSULATION

Hair and Wool Felt Pipe Covering - Code 8A

Blanket Hair Felt - Code 8B

7.1 These materials are used to protect pipe lines from freezing. Code 8A is for use on pipes and Code 8B is for use on fittings and valves.

8.0 FILL INSULATION

Cork Dust - Code 9A

Granulated Mineral Wool - Code 9B

8.1 These materials may be used for filling small void places when applying other insulations listed above.

9.0 AUXILIARY MATERIALS

9.1 The auxiliary materials are coded by single letter or symbol defined under Auxiliary Materials in Section C. These materials require no selection by the Owner's Representative except that in an unusual application, in addition to selecting the insulating material, thickness, and finish, the Representative should check through the method of application of each of the auxiliaries (See Section B).

10.0 THICKNESS OF INSULATION

10.1 Where insulation in Class 1 is required, the drawings shall indicate Class 1 and the efficiency required as selected from Table I on the following page, and, in addition, the working temperature of the line and the finish required. For example, a 4-inch steam line at 150-psi working pressure and 350°F, and where no special conditions prevail, would be noted: "Insulation-Class 1, 92% efficiency required, 350°F, Fin. F, See Specification."

10.2 Where insulation in other classes is required, the code number of the material, thickness, and finish shall be stated on the the drawing. In cases where only the temperature, material, and service conditions are shown on the drawings, the tables can be used to establish the thickness required.

TABLE I

Insulation Efficiency Required for Heated Surfaces

| Pressure Psi | Temperature °F | Efficiency Required | | | | |
|---|---|---|---|---|---|---|
| | | Pipe 1" and Under | Pipe 1-1/4" to 2-1/2 | Pipe 3" to 5" | Pipe 6" to 9" | Equipment and Pipe 9" and Over |
| 0 to 67 | 111 to 299 | 82.0 | 84.5 | 86.0 | 88.0 | 89.0 |
| 68 to 240 | 300 to 399 | 87.0 | 90.0 | 92.0 | 94.0 | 95.5 |
| 241 to 680 | 400 to 499 | 89.0 | 92.0 | 94.0 | 95.5 | 96.0 |
| Super Heat | 500 to 600 | 90.0 | 93.0 | 94.5 | 96.0 | 96.2 |

Notes:

Actual thickness of insulation is determined by locating the above efficiency in the proper temperature column in the material manufacturer's heat loss and efficiency tables and reading the thickness which will provide equal or greater efficiency. Since thermal conductivity varies with the material, the trade name should accompany the thickness where insulation is specified or discussed in terms of thickness.

The efficiency as used above is the quotient, expressed as percentage, of the heat saved by the insulation divided by the heat which would be lost without insulation. The heat which would be lost is taken as the loss from horizontal bare iron pipe. (See Table V in Appendix A.) Heat saved by various thicknesses is listed in the manufacturer's information on the specific material.

TABLE II

Thickness
Corrugated Asbestos

| Steam Pressure Psi | Temperature °F | Thickness in Number of Plies Each Ply 1/4" Thick | |
|---|---|---|---|
| | | Pipes Over 4" | Pipes 4" and Under |
| 0 to 15 | 70 to 250 | 6 Ply | 4 Ply |
| 15 to 25 | 251 to 300 | 8 Ply | 6 Ply |

10.3 Blanket, block, and board insulation thickness can be selected by reference to preceding tables for similar applications and allowance made for the service conditions.

10.4 The thickness of molded vegetable cork (Code 6A), molded impregnated mineral wool (Code 6B), and mineral wool felt can be obtained from the following table:

TABLE III

Thickness
Vegetable Cork - Code 6A
Mineral Wool - Code 6B

| Temperature °F | Pipe and Fittings Under 12" Diameter* | Lagging for Equipment and Pipe 12" diameter & Over |
|---|---|---|
| Above 30 | Ice water thick 1.2" to 1.9" | 2" |
| 10 to 30 | Brine thick 1.7" to 3.0" | 4" |
| -15 to 10 | Heavy brine thick 2.6" to 4.0" | 6" |

* Thickness varies according to size of pipe

10.5 Ground Cork and Asphalt (Code 7A) is used as a 1/4-inch-thick coating on pipes 5-inch diameter and larger to prevent sweating of cold water lines ($40^{\circ}$ to $75^{\circ}$F).

10.6 Insulating Felt (Code 7B) is molded pipe covering used in single-layer one inch thickness on pipes up to 5-inch diameter to prevent sweating of cold water lines ($40^{\circ}$ to $75^{\circ}$F) where required.

10.7 Anti-freeze insulation thicknesses are not given here since the thickness required for protection against freezing must be based upon the rate of flow, length of line, minimum atmospheric temperature, temperature of fluid entering the pipe, and other factors. See Table IV at end of Section A.

TABLE IV

Data on Freezing of Water in Pipes *

| Pipe size, inches | Hair-Felt Insulation, No. of layers each 1 in. thick | Btu per deg temp.diff., per hour per lineal ft | Hours to cool to freezing point** | Lb water flow at 42°F per hr per lineal ft to prevent freezing |
|---|---|---|---|---|
| 1/2 | 2 | .0895 | .417 | .537 |
| | 3 | .0747 | .500 | .448 |
| | 4 | .0660 | .565 | .396 |
| 1 | 2 | .1125 | .825 | .675 |
| | 3 | .0911 | 1.02 | .548 |
| | 4 | .0798 | 1.16 | .480 |
| 1 1/2 | 2 | .1400 | 1.40 | .840 |
| | 3 | .1126 | 1.74 | .676 |
| | 4 | .0972 | 2.02 | .583 |
| 2 | 2 | .1586 | 1.94 | .952 |
| | 3 | .1244 | 2.48 | .747 |
| | 4 | .1063 | 2.90 | .638 |
| 3 | 2 | .2062 | 3.25 | 1.237 |
| | 3 | .1572 | 4.27 | .943 |
| | 4 | .1322 | 5.08 | .793 |
| 4 | 2 | .2450 | 4.55 | 1.470 |
| | 3 | .1850 | 6.02 | 1.110 |
| | 4 | .1548 | 7.20 | .929 |
| 5 | 2 | .2887 | 5.92 | 1.733 |
| | 3 | .2146 | 7.96 | 1.289 |
| | 4 | .1764 | 9.69 | 1.059 |
| 6 | 2 | .3302 | 7.35 | 1.981 |
| | 3 | .2434 | 9.88 | 1.460 |
| | 4 | .1984 | 12.20 | 1.191 |
| 8 | 2 | .4100 | 10.05 | 2.460 |
| | 3 | .2960 | 13.90 | 1.776 |
| | 4 | .2390 | 17.25 | 1.434 |
| 10 | 2 | .4930 | 13.00 | 2.960 |
| | 3 | .3536 | 18.10 | 2.122 |
| | 4 | .2830 | 22.70 | 1.698 |
| 12 | 2 | .5720 | 15.80 | 3.432 |
| | 3 | .4090 | 22.20 | 2.454 |
| | 4 | .3222 | 28.10 | 1.933 |

*

** For foot notes see next page.

* In the above table, the effect of varying temperature difference due to cooling of the water has been ignored, as this is an unnecessary refinement where large factors of safety are required. The only effect of not considering this varying temperature difference is to increase the factor of safety.

** The fourth column is the time in hours necessary for water in a pipe to be cooled from 42 to 32 deg F, with a difference in temperature between water and air of 60 deg F, which would correspond to an air temperature of about 20 deg F below zero. The time shown in the table is the time to lower the water to the freezing point. Much longer time would be required actually to freeze all of the water in the pipes, but once it starts to freeze, the danger point has been reached.

## SECTION B

## GENERAL

1.0 INTENT

1.1 This section covers the code designation of insulating materials for piping and equipment up to temperatures of 600°F, and methods used in establishing payment.

2.0 CODE MEANING

2.1 The specification uses a system of code letters and numbers to designate insulation materials, auxiliary materials, and the various finishes. (See Section C - Materials.) Use of the code system is summarized as follows:

2.1.1 Insulating materials are designated by a class number and a letter for the specific material within that class. Thus, 1C means Class 1 molded insulation; specific material "C," which is asbestos.

2.1.2 Auxiliary materials are designated by a single letter. Thus, "B" means cut-back plastic.

2.1.3 Finish is designated by abbreviation of the word "finish" followed by a single letter. Thus, "Fin. D" means cement finish. (See Section E.)

3.0 INFORMATION ON DRAWINGS

3.1 The method of designation is shown under paragraph 10.0, "Thickness of Insulation," in Section A.

3.2 Where only certain materials provided in this specification

are suitable due to unusual conditions, the drawings shall state the material and note that no substitute will be permitted.

3.3 The drawings should state finish required as selected from Section E of this specification.

3.4 When corrugated asbestos (Code 2A) is specified, the drawings should note whether the valves and fittings are to be covered. Generally these are left uncovered indoors in locations where personnel are not likely to be burned. The contractor will insulate all flanges, valves, and fittings unless otherwise specified.

3.5 Where corrosive or other unusual conditions prevail which make the use of bands and wires listed in Table IV of Appendix A impractical, the drawings should specify suitable materials.

4.0 DEFINITION OF TERMS

4.1 The words Owner's Representative as used in this specification shall mean the Owner or his Representative.

4.2 The word Contractor as used in this specification shall mean the party contracting to furnish the materials and perform the services required by this specification.

5.0 MEASUREMENT AND PAYMENT

5.1 Payment for insulation in place shall be made on a unit price basis unless otherwise specifically provided in writing.

5.2 Detail measurements shall be taken and recorded by the Contractor on survey sheets, showing the location, the amount of straight pipe, bent pipe, number of fittings, class of insulation, etc.

The measurements will be used in calculating the payment to be made for insulation. At the end of each day on which measurements are made, a set of drawings shall be marked by the Contractor to show which lines have been included in the exact limits of the measurement. The Contractor shall complete measurements within each building or for each outside line within a reasonable period of time. Unless otherwise mutually agreed upon, a reasonable period of time shall be considered as the time required to complete the insulating work plus two days after completion of the insulating work. The survey sheets and marked drawings shall be available at all times for examination by the Owner's Representative. The following method shall be followed in measuring insulation for payment:

5.2.1 Measurements shall be made over the exterior of the covering to determine the quantities of insulation. The outside, or longest radius curve, shall be used in measuring curved pipe, such as ells and pipe bends.

5.2.2 The quanity of insulation in all cases shall be determined by actual measurement and shall not be calculated from drawings or by visual estimate, except in special cases where permission is given by the Owner's Representative.

5.2.3 All measurements shall be made with a linen tape. This tape should be checked daily, to insure its accuracy. A representative of each interested party shall be present when measurements are made.

5.2.4 In measuring pipe covering, the over-all length, including fittings, valves, etc., shall be taken, unless otherwise specified. To this shall be added a footage allowance for each valve, fitting, etc., as per Tables V, VI, and VII. An exception to this is bent piping, which shall be measured separately and multiplied by a factor given in Tables V, VI, and VII. Another exception to this is separators, which shall be measured on a square-foot basis as equipment, and the measurement of the pipe shall not include the separators.

5.2.5 Welded tees, whether field or factory fabricated, shall not be classed as fittings for purpose of payment, but the diameter of the straight section tee'd into shall be added to the linear measurement of the branch line. The straight section of pipe through the tee shall be measured continuously.

5.2.6 None of the flanges on or bolted to a flange fitting shall be counted separately, but shall be considered as part of the fitting. For example, a flange tee together with the three attached flanges shall count only as a flange tee.

5.2.7. Measurements of cylindrical equipment shall be made on the following basis:

| Type head | Length of Cylinder |
|---|---|
| Convex or Dished | Knuckle to knuckle |
| Flat, Concave or Special | End to end of cylindrical section |

Cylindrical surface area shall be computed as the length of the cylinder multiplied by the outside circumference

over the insulation.

Ends shall be counded as the square of the outside diameter of the cylindrical covering. For conical or other specially shaped ends, the actual superficial area shall be taken. There shall be no deductions made for manholes or similar openings.

5.2.8 Insulation used as fill material for panel insulation or for filling only the void spaces in a box enclosing coils, pumps, and such equipment, shall be measured as a total volume of the panel or box. No additional payment is allowed for using fill materials as auxiliaries. The Owner's Representative may call for certain irregularly shaped equipment to be boxed with wood or sheet metal and the box filled with one of the above materials. In this case, the Contractor would be paid for the fill insulation by the cubic foot of space filled.

5.2.9 Covers for line flanges, valves, and fittings, Class 1, 2, and 4, shall have minimum lengths as shown in Appendix B. The number of flange covers shall be counted, not the number of flanges. If the cover is longer than called for, no allowance shall be made, unless more than one line-flange joint or valve is enclosed. In this case, an allowance shall be made for the extra cover on the basis of additional fraction of a cover added.

5.2.10 Where two or more pipes are covered together under the same premolded covering, the actual size of covering used shall be measured as described in this section

and shall be counted as 1.5 times the straight pipe covering used. Where two or more lines are covered as a group with Code 4A insulation, the actual size pipe covering used shall be measured as previously described, and shall be paid for as straight pipe.

5.2.11 Hanger rod factors will apply only in cases where the hanger rods themselves are insulated.

5.2.12 In special cases where no factor for payment has been specified, or where methods given herein do not apply, the Contractor and the Owner's Representative shall agree on payment to be made before starting work.

5.2.13 In measuring pipe covering, all measurements shall be taken to the nearest foot.

5.2.14 Line flanges, flanged fittings, or flanged valve covers shall be molded or built-up insulation of the same material as applied to the adjacent piping, thickness as hereinafter specified, and so installed that they will lap over the pipe covering as described in Figures 10, 11, 13 and 14, Appendix B. Line flanges, flanged fittings, or valve covers shall not be made by digging out the pipe covering to allow line flange, flanged fitting, or valve to be recessed in the pipe covering. Where pipe covering is dug out, this shall be considered a special case and paid for in accordance with 5.2.12.

5.2.15 Pipe bends having a radius of 4 diameters or less shall be considered as fittings. Pipe bends having a radius of over 4 pipe diameters shall be considered as bent pipe.

5.2.16 Where a line is heated electrically by running the electric wire parallel with the pipe and covered, it shall be counted as described in 5.2.10 where two or more pipes are covered together using the factor 1.5 times the straight pipe. Where the electric wire is wrapped spirally around the pipe or strip heaters are used and covered, the actual pipe-size covering used shall be paid for as straight pipe. Payment for providing each opening for electric wires in pipe covering shall be counted as 20% of the unit price established for the size and the code of covering used.

5.2.17 The size of traps shall be computed on the basis of the size of the pipe entering the trap.

5.3 Where insulation is to be removed due to no fault of the Contractor, the work in removing the insulation shall be paid for on the basis of 50 percent of the unit prices established for that particular type of insulation which is to be removed.

All insulation removed is to become the property of the Owner. Where new material is to be installed in place of that removed, the new material shall be paid for as such at established unit prices.

5.4 Partial removal and/or repair of material for cases where only a part of a valve or fitting cover is removed and/or repaired, payment for such removal and/or repair shall be on the basis mutually agreed upon in writing by the Owner.

5.5 Defective insulation material and accessories not complying

with the specifications will be rejected and shall be removed without charge, and replaced with approved insulation accessories applied at no extra charge.

6.0 SUBSTITUTION OF MATERIALS

6.1 No substitution of material will be permitted unless the following conditions are met in making the substitution:

6.1.1 Cost of completed job will not be increased.

6.1.2 Heat transfer rate will not be increased, and the efficiency will not be less.

6.1.3 The substituted material will, in the opinion of the Owner, withstand the service conditions to the same or greater extent as the material being replaced.

6.2 Subject to 6.1.1 and 6.1.2 the following substitutions will be permitted:

6.2.1 Any material classified under Class 1 for any other material under Class 1.

6.2.2 Any material in Class 1 for Code 2A material but not vice versa.

6.2.3 Code 7B for Code 2A but not vice versa.

6.2.4 Code 1B for Code 6B, 7B, or 8A but not vice versa.

6.3 Where materials are substituted according to the conditions in 6.1 and 6.2 above, the method of application and finish shall be the same as for the material displaced unless modification is approved by the Owner in writing.

TABLE V

Lengths of Straight Pipe in Feet Equivalent to Fittings for All Thicknesses and Sizes.

| | For Pipe Covered With Insulation Code No.: | 1A, 1B, 1C, 2A, 7B, 8A | 6B | 6C & 8B | 7A |
|---|---|---|---|---|---|
| SCREWED | Ells & 45° | 2.0 | 1.5 | 1.0 | 1.0 |
| | Tees | 2.5 | 2.0 | 2.0 | 1.0 |
| | Valves & Crosses | 3.0 | 2.5 | 4.0 | 1.0 |
| | Unions | Not Insulated | 1.5 | 1.5 | 1.0 |
| | Check Valves | 3.0 | 3.0 | 4.0 | 1.0 |
| | Reducers | 2.5 | 2.0 | 2.0 | 1.0 |
| | Y's | 3.0 | 2.5 | 2.0 | 1.0 |
| WELDED | Ells & 45° | 2.0 | 1.5 | 1.0 | 1.0 |
| | Reducers | 2.5 | 2.0 | 1.5 | 1.0 |
| | Expansion Joints | 4.5 | | | 1.0 |
| | Y's | 3.0 | 2.5 | 2.0 | 1.0 |
| FLANGED | Ells & 45° | 5.0 | 4.0 | 4.0 | 2.0 |
| | Tees | 8.5 | 7.5 | 5.0 | 2.0 |
| | Crosses & Valves | 10.0 | 8.0 | 6.0 | 2.0 |
| | Check Valves | 8.0 | 6.0 | 5.0 | 2.0 |
| | Reducers | 5.0 | 4.0 | 2.0 | 2.0 |
| | Line Flanges | 3.0 | 2.0 | 2.0 | 1.5 |
| | Y's | 9.0 | 6.0 | 3.0 | 2.0 |
| | Expansion Joints | 9.0 | 7.5 | | |
| MISC. | Traps | Not Insulated | | | Not Insulated |
| | Strainers | 5.0 | 5.0 | 3.0 | Not Insulated |
| | Bent Pipe | 1.5 | 1.5 | 1.0 | 1.0 |
| | Hanger Rods | Not Insulated | 1.5 | 1.5 | Not Insulated |

Nipples, couplings, caps, and all items not listed in this table shall not be classed as fittings for purposes of payment.

TABLE VI

Lengths of Straight Pipe in Feet Equivalent to Fittings for Ice Water Thick Cork - Code 6A

| | Pipe Sizes | 1/2 | 3/4 | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCREWED | Ell | 3.2 | 3.2 | 3.1 | 3.0 | 3.0 | 3.0 | 2.9 | 2.9 | 2.8 | 2.5 | 2.2 | 2.0 | | | | | |
| | Tee | 3.4 | 3.3 | 3.3 | 3.2 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.6 | 2.6 | 2.2 | | | | | |
| | 45° | 3.5 | 3.5 | 3.4 | 3.3 | 3.3 | 3.3 | 3.2 | 3.2 | 3.1 | 3.0 | 2.8 | 2.7 | | | | | |
| | Valve | 4.4 | 4.4 | 4.3 | 4.3 | 4.3 | 4.3 | 4.2 | 4.2 | 4.1 | 4.0 | 4.0 | 4.0 | | | | | |
| | Union | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | | | | | |
| | Cross | 4.6 | 4.5 | 4.5 | 4.4 | 4.4 | 4.1 | 4.1 | 3.9 | 3.9 | 3.4 | 3.4 | 2.9 | | | | | |
| | Check Valve | 4.4 | 4.4 | 4.3 | 4.2 | 4.2 | 4.2 | 4.1 | 4.0 | 4.0 | 4.0 | 3.9 | 3.7 | | | | | |
| | Y's | 3.5 | 3.5 | 3.5 | 3.4 | 3.4 | 3.2 | 3.1 | 3.0 | 3.0 | 2.7 | 2.7 | 2.4 | | | | | |
| | Reducer | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.0 | | | | | |
| WELDED | Ell | 4.2 | 4.2 | 4.2 | 4.1 | 4.1 | 4.1 | 4.0 | 3.9 | 3.8 | 3.6 | 3.3 | 3.1 | 2.8 | 2.6 | 2.5 | 2.3 | 2.0 |
| | 45° | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.4 | 4.4 | 4.3 | 4.3 | 4.2 | 4.1 | 4.0 | 3.8 | 3.6 | 3.5 | 3.3 |
| | Tee | 4.1 | 4.1 | 4.0 | 4.0 | 4.0 | 3.9 | 3.8 | 3.7 | 3.6 | 3.6 | 3.5 | 3.3 | 3.0 | 2.5 | 2.2 | 2.2 | 2.2 |
| | Y's | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.3 | 2.0 | 1.5 | 1.2 | 1.2 | 1.2 |
| | Reducer | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | 0.7 |
| FLANGED | Valve | 12.6 | 12.6 | 12.5 | 12.5 | 12.5 | 12.5 | 12.4 | 12.4 | 12.4 | 12.3 | 12.0 | 12.0 | 12.0 | 11.7 | 11.6 | 11.5 | 11.4 |
| | Tee | 9.1 | 9.0 | 9.0 | 8.9 | 8.9 | 8.7 | 8.7 | 8.5 | 8.3 | 8.1 | 7.9 | 7.6 | 7.3 | 6.9 | 6.5 | 6.0 | 5.5 |
| | Ell | 6.1 | 6.0 | 6.0 | 6.0 | 6.0 | 5.8 | 5.6 | 5.6 | 5.4 | 5.4 | 5.0 | 4.8 | 4.4 | 3.9 | 3.6 | 3.1 | 2.7 |
| | 45° | 6.7 | 6.6 | 6.6 | 6.6 | 6.6 | 6.5 | 6.5 | 6.5 | 6.4 | 6.3 | 6.1 | 6.0 | 5.8 | 5.6 | 5.4 | 5.1 | 5.0 |
| | Check Valve | 11.6 | 11.6 | 11.6 | 11.4 | 11.4 | 11.4 | 11.3 | 11.2 | 11.1 | 11.0 | 11.0 | 10.9 | 10.2 | 9.8 | 9.5 | 9.2 | 8.8 |
| | Cross | 10.9 | 10.8 | 10.8 | 10.8 | 10.8 | 10.5 | 10.3 | 10.1 | 9.8 | 9.6 | 9.5 | 9.3 | 9.0 | 8.6 | 7.8 | 7.5 | 6.8 |
| | Blank Flange | 3.7 | 3.7 | 3.9 | 3.9 | 3.9 | 3.9 | 3.3 | 3.5 | 3.5 | 3.5 | 3.4 | 3.4 | 3.3 | 3.3 | 3.3 | 3.1 | 3.1 |
| | Line Flange | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | Y's | 7.1 | 7.0 | 7.0 | 6.9 | 6.9 | 6.7 | 6.6 | 6.5 | 6.3 | 6.1 | 5.9 | 5.6 | 5.3 | 4.9 | 4.5 | 4.0 | 3.5 |
| | Reducer | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.2 | 5.2 | 5.2 | 5.1 | 5.0 | 5.0 | 4.9 | 4.8 | 4.8 | 4.7 |
| MISC. | Bent Pipe | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| | Strainers | To be paid for in accordance with the bid price on each unit. | | | | | | | | | | | | | | | | |
| | Hanger Rods | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |

TABLE VII

Lengths of Straight Pipe in Feet Equivalent to Fittings for Brine or Special Brine Thick Cork - Code 6A

| | Pipe Sizes | 1/2 | 3/4 | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCREWED | Ell | 4.2 | 4.2 | 4.1 | 4.0 | 4.0 | 4.0 | 3.9 | 3.9 | 3.8 | 3.5 | 3.2 | 3.0 | | | | | |
| | Tee | 4.4 | 4.3 | 4.3 | 4.2 | 4.2 | 4.1 | 4.0 | 3.9 | 3.8 | 3.5 | 3.5 | 3.2 | | | | | |
| | 45° | 4.5 | 4.5 | 4.4 | 4.3 | 4.3 | 4.3 | 4.2 | 4.2 | 4.1 | 4.0 | 3.8 | 3.7 | | | | | |
| | Valve | 5.4 | 5.4 | 5.3 | 5.3 | 5.3 | 5.3 | 5.2 | 5.2 | 5.1 | 5.1 | 5.0 | 5.0 | | | | | |
| | Union | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | | | | | |
| | Cross | 5.6 | 5.5 | 5.5 | 5.4 | 5.4 | 5.1 | 5.1 | 4.9 | 4.9 | 4.4 | 4.4 | 3.9 | | | | | |
| | Check Valve | 5.4 | 5.4 | 5.3 | 5.2 | 5.2 | 5.1 | 5.1 | 5.0 | 5.0 | 5.0 | 4.9 | 4.7 | | | | | |
| | Y's | 3.5 | 3.5 | 3.5 | 3.4 | 3.4 | 3.2 | 3.1 | 3.0 | 3.0 | 2.7 | 2.7 | 2.4 | | | | | |
| | Reducer | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.0 | | | | | |
| WELDED | Ell | 6.0 | 6.0 | 6.0 | 5.9 | 5.9 | 5.9 | 5.7 | 5.6 | 5.5 | 5.4 | 5.0 | 4.9 | 4.5 | 4.4 | 4.2 | 4.0 | 3.7 |
| | 45° | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.1 | 6.1 | 6.0 | 6.0 | 6.0 | 5.9 | 5.7 | 5.5 | 5.4 | 5.2 | 5.0 |
| | Tee | 3.9 | 3.9 | 3.8 | 3.7 | 3.7 | 3.6 | 3.5 | 3.5 | 3.4 | 3.4 | 3.2 | 3.0 | 2.7 | 2.3 | 2.0 | 2.0 | 2.0 |
| | Y's | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.3 | 2.0 | 1.5 | 1.2 | 1.2 | 1.2 |
| | Reducer | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | 0.6 |
| FLANGED | Valve | 12.6 | 12.6 | 12.5 | 12.5 | 12.5 | 12.5 | 12.4 | 12.4 | 12.4 | 12.3 | 12.0 | 12.0 | 12.0 | 11.7 | 11.6 | 11.5 | 11.4 |
| | Tee | 13.1 | 13.0 | 13.0 | 12.9 | 12.9 | 12.7 | 12.5 | 12.5 | 12.3 | 12.1 | 11.9 | 11.6 | 11.3 | 10.9 | 10.5 | 10.0 | 9.5 |
| | Ell | 6.9 | 6.8 | 6.8 | 6.7 | 6.7 | 6.5 | 6.4 | 6.4 | 6.1 | 6.1 | 5.8 | 5.5 | 5.1 | 4.6 | 4.4 | 3.9 | 3.5 |
| | 45° | 7.5 | 7.4 | 7.4 | 7.4 | 7.4 | 7.3 | 7.3 | 7.2 | 7.1 | 7.0 | 6.9 | 6.8 | 6.5 | 6.4 | 6.1 | 5.9 | 5.7 |
| | Check Valve | 11.6 | 11.6 | 11.6 | 11.4 | 11.4 | 11.4 | 11.3 | 11.2 | 11.1 | 11.0 | 11.0 | 10.9 | 10.2 | 9.8 | 9.5 | 9.2 | 8.8 |
| | Cross | 10.9 | 10.8 | 10.8 | 10.8 | 10.8 | 10.5 | 10.3 | 10.1 | 9.8 | 9.6 | 9.5 | 9.3 | 9.0 | 8.6 | 7.8 | 7.5 | 6.8 |
| | Blank Flange | 3.7 | 3.7 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 3.5 | 3.5 | 3.5 | 3.4 | 3.4 | 3.3 | 3.3 | 3.3 | 3.1 | 3.1 |
| | Line Flange | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | Y's | 8.1 | 8.0 | 8.0 | 7.9 | 7.9 | 7.7 | 7.5 | 7.5 | 7.3 | 7.1 | 6.9 | 6.6 | 6.3 | 5.9 | 5.5 | 5.0 | 4.5 |
| | Reducer | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.2 | 6.2 | 6.2 | 6.1 | 6.0 | 6.0 | 5.9 | 5.8 | 5.8 | 5.7 |
| MISC. | Bent Pipe | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| | Strainer | To be paid for in accordance with the bid price on each unit. | | | | | | | | | | | | | | | | |
| | Hanger Rod | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |

EXHIBIT A - SPECIMEN SURVEY SHEET

Sheet 1 of 1
Date Dec. 16, 1956

INSULATION - Code 6A
FINISH - Type F

Project No. Q 43 Bldg. No. 17125

Measured by Richard Roe

Service - 15° Brine Line Drg. No. H-2-4726

Inspector John Doe

| Pipe Size | 1" | 1½" | | | | | |
|---|---|---|---|---|---|---|---|
| Pipe insulated: (feet) | 20'<br>20'<br>30'<br>60'<br>50'<br>100'<br>280 ft | 300'<br>160'<br>6'<br>17'<br>483 ft | | | | | |
| Fittings insulated: | 10 $L^S$<br>5 U<br>4 $V^S$<br>6 $T^W$ | 12 F<br>5 $L^W$<br>3 $L^S$<br>20 $T^S$<br>5 $V^S$ | | | | | |

The following symbols may be used when marking Survey Sheets:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $L^S$ | Screwed ell and 45° fitting | $T^S$ | Screwed Tee | $Cro.^S$ | Screwed crosses | $Y^S$ | Screwed Y |
| $L^W$ | Welded ell and 45° fitting | $T^W$ | Welded Tee | $Cro.^f$ | Flanged crosses | $Y^W$ | Welded Y |
| $L^f$ | Flanged ell and 45° fitting | $T^f$ | Flanged Tee | $Red^S$ | Screwed Reducer | $Y^f$ | Flanged Y |
| $C.V.^S$ | Screwed Check Valves | $V^S$ | Screwed Valves | $Red^W$ | Welded Reducer | Trp. | Traps |
| $C.V.^f$ | Flanged Check Valves | $V^f$ | Flanged Valves | $Red^f$ | Flanged Reducer | Str. | Strainers |
| $Ex.^W$ | Welded Expansion Joint | U | Union | F. | Line Flange | B.P. | Bent Pipe |
| $Ex.^f$ | Flanged Expansion Joint | | | | | H.R. | Hanger Rods |

## SECTION C

## MATERIALS

### 1.0 GENERAL

All insulating materials shall be of uniformly high quality. In response to the invitation to bid, the bidder shall state the commercial names and the manufacturers of material which he proposes to furnish. The Contractor shall use only materials listed by him on his quotation, except that where procurement or other unforeseen difficulties arise, the Owner's Representative may approve other products of comparable quality. Where trade names are used in this specification, they are intended to indicate the kind, type, and quality of product required. Other materials which will provide equivalent performance under the service conditions for which the product named is suitable will be acceptable as an approved equal. The Owner shall have the right to make the final decision as to what will be accepted as an approved equal. Materials installed shall meet the respective manufacturers' published specifications for that material.

### 2.0 CLASS 1 INSULATION

2.1 Code 1A insulation for use at temperatures up to 600°F shall be 85% magnesia molded pipe insulation, or block insulation. Preformed pipe insulation shall be furnished with a 3-1/2-ounce or heavier canvas jacket.

2.2 Code 1B insulation shall be a spun glass product consisting of fine, flexible glass fibers, blown or spun from molten glass, formed into molded pipe covering, or blocks or boards

for large pipe and fittings and valves. A suitable binder, not decomposed by temperatures up to 600°F, shall be used in forming the molded insulation. The molded insulation shall be fibrous, nonfriable and semirigid, yet resilient when compressed. Material temperature range shall be up to 600°F.

Preformed pipe insulation shall be furnished with a 4-ounce canvas jacket. At 300°F temperature difference, the thermal conductivity shall not be more than 0.35 Btu/hr sq ft °F/in. for molded pipe insulation. For block or board insulation, the density shall be 6 to 10 pounds per cu ft and the thermal conductivity shall not be greater than 0.41 Btu/hr sq ft °F/in at 300°F mean temperature.

2.3 Code 1C insulation shall be felted laminated asbestos consisting of 36 to 42 laminations per inch of an asbestos felt to which other stable material has been added to produce a porous insulator.

3.0 CELLULAR INSULATION

3.1 Corrugated Asbestos, Code 2A, shall be Johns-Manville's "Asbestocel" or approved equal consisting of alternate layers of 4 plain and 4 corrugated asbestos sheets per inch. The insulation shall conform to the latest issue of Federal Specification HH-I-561, Type III.

4.0 BLANKET INSULATION

4.1 Mineral Wool Blanket, Code 4A, shall be Johns-Manville's "Banroc," Owens-Corning's "Fiberglas," or approved equal metal-faced blanket composed of mineral wool fibers formed

into a blanket and reinforced by expanded metal on one side and galvanized 1-inch-mesh netting on the other side. The blanket shall meet the requirements of the latest issue of Federal Specification HH-P-387, Type II.

5.0 LOW TEMPERATURE INSULATIONS

5.1 Code 6A, shall be vegetable cork, granulated and compressed into corkboard form, or pressed into molds, and baked at moderate temperature. The natural resin in the cork shall constitute the binder for cementing the granules together. The molded material shall be coated inside and out with a waterproof asphalt coating. Corkboard shall comply with the latest issue of Federal Specification HH-C-561. Molded cork shall comply with the latest issue of Federal Specification HH-P-381.

5.2 Impregnated Mineral Wool, Code 6B, shall be Johns-Manville's "Rock Cork" or approved equal, consisting of mineral wool fibers and a waterproofing binder so impregnated as to produce a homogeneous mass. It shall be molded material meeting the latest issue of Federal Specification HH-M-371, Types I, II, III, and IV.

5.3 Mineral Wool Felt, Code 6C, shall be Johns-Manville's "Zerotex" or approxed equal, impregnated mineral wool felt with a waterproofing binder. It shall comply with Federal Specification HH-M-371, Type V.

6.0 ANTI-SWEAT INSULATION

6.1 Ground Cork and Asphalt, Code 7A, shall be Insul-Mastic's

No 553S or 553T, or equal, approved plastic material containing approximately 65 to 70% of cork by volume, which when dry will be highly resistant to acids, alkali, salt solutions, and vapors. Its consistency shall be suitable for troweling or spraying. It shall adhere permanently to any surface to which it is applied and shall not contain water. After drying, it shall not absorb water, flow, sag, check, or crack. It shall protect all construction materials, including aluminum, from corrosion. The material temperature range shall be -40° to + 300°F and the thermal conductivity at 70°F shall not be over 3.6 Btu/sq ft hr °F/in. This material is suitable for use as anti-drip coating on 5-inch pipes and larger. On smaller pipes apply insulating felt, Code 7B.

6.2 Insulating Felt, Code 7B, shall be Johns-Manville's "Pre-Shrunk Wool Felt" or Carey's "Perfecto," or approved equal, consisting of laminations of felt composed of cellulose, animal hair, animal wool, or mineral fibers and filler. The insulation shall be suitable for use on cold water lines up to 5-inch diameter to prevent sweating. To prevent sweating on larger lines use Code 7A. The value of the thermal conductivity at 70°F shall not exceed 0.55 Btu/hr sq ft °F/in. Subject to Section B, paragraph 6.0, this material may be substituted for Code 2A insulation.

7.0 ANTI-FREEZE INSULATION

7.1 Hair and Wool Felt Pipe Covering, Code 8A, shall be Johns-Manville's "Zero Pipe Insulation" or Carey's "Protecto," or approved equal, formed pipe insulation consisting of layers

of hair felt and insulating felt so arranged to provide efficient protection to the hair felt. The formed sections shall incorporate a waterproof felt inner liner. The insulation shall be suitable to protect water lines against freezing. At 70°F, the thermal conductivity shall not exceed 0.30 Btu/hr sq ft °F/in.

7.2 Blanket Hair Felt, Code 8B, shall be "Navy Standard" made from 100% selected cattle hair intertwined into sheets. Material temperature range shall be -180° to + 180°F. The thermal conductivity at 75°F shall not be over 0.25 Btu/hr sq ft °F/in.

8.0 FILL INSULATION

8.1 Cork Dust, Code 9A, shall be raw cork size 40 mesh to dust weighing 20 to 25 pounds per cu ft. Material temperature range shall be -180° to + 250°F.

8.2 Code 9B, shall be granulated mineral wool. This is a pellet form, suitable for pouring or blowing into irregular spaces. It shall be water-repellent, nonsettling, resilient, and noncorrosive. Material temperature range shall be -180° to + 1200°F. The value of the thermal conductivity when the temperature is 500°F and the density is 5 to 10 pounds per cu ft shall not exceed 0.40 Btu/hr sq ft °F/in.

9.0 INSULATION AUXILIARIES

9.1 Angle Iron Bands are standard angles formed to fit snugly around a tank and are used to secure wire or bands holding the insulation. See Table III, Appendix A.

9.1 Asphalt Cement, Code A, shall be composed of suitable inorganic filler, solvent, and asphalt binder to which organic products may be added. This cement shall show no cracking of the cement or separation of the metal and cement when applied to metal test pieces cooled for one hour at 32°F and quickly bent over a 1-inch-diameter mandrel per Navy Specification # 7-Cement, Bituminous and Plastic, Bureau of Yards and Docks, Navy Department.

9.2 Asphalt Coating, also called Heavy Mastic, either factory or field applied, used on cork pipe covering, or cork covering for flanges, valves, and fittings, shall be 235° to 250°F melting point, oxidized asphalt. Factory applied material on pipe covering may have approximately 10% diatomaceous earth filler added to stiffen the coating and facilitate machine application. Coating shall be applied in successive layers to give a total thickness of not less than 1/8inch. This material may be obtained from Standard Oil Company of New Jersey, The Texas Company, Mexican Petroleum Corporation, and similar refineries.

9.3 Asphalt Cut-Back Plastic or Flashing, Code B, shall consist of plastic material of uniform quality cut back with a volatile solvent to troweling consistency. The product shall not flow, sag, crack, or check over a temperature range of -40° to + 300°F and shall not absorb moisture. The material shall bond securely to metal, asphalt, cloth, wood, paint, or clean and dry concrete, and the various insulating materials to which it is applied. It shall be suitable for

application cold in film thicknesses up to $\frac{1}{4}$ inch. This material shall form a durable, acid-, alkali-, and weather-resistant, elastic vapor seal.

9.4 Breathing Plastic, Code C, shall be asphalt emulsion plastic of uniform quality, premixed by the manufacturer to troweling consistency and ready to apply as received. The product shall not flow, sag, check, or crack over a temperature range of -40° to + 300°F. It shall be fire resistant, and the lateral shrinkage length or width in drying shall not exceed 3%. Tensile strength of air-dried material shall not be less than 325 pounds per sq in. The water-vapor permeability of a dried sample of this material applied wet, $\frac{1}{4}$ inch thick, shall be within the range of 0.1 to 0.6 ounce of water per 24 hours per sq ft at a temperature of 25°C and a pressure differential of 11.9 millimeters of mercury. This material shall form a durable, acid-, alkali-, and weather-resistant, elastic finish. Where breathing plastic may be subject to freezing temperatures before use, anti-freeze may be added as recommended by the manufacturer of the plastic. At the purchaser's request, this shall be added by the manufacturer prior to shipment. Shipping drums or containers shall be large enough to receive anti-freeze if it has not been added by the manufacturer. Care is to be taken that the recommended amount of anti-freeze is not exceeded or the emulsion may be broken, with resultant spoilage of the product. Breathing plastic shall not be applied at temperature below the minimum recommended by the manufacturer. If this

finish is to be applied when such temperatures exist, heat shall be provided to warm the space and surfaces involved accordingly.

A minimum of troweling is to be done in applying this plastic. In the process of drying, the material shrinks in thickness and minor surface marks will disappear. One coat of breathing plastic will require at least 60 hours to dry. In damp weather this time may be extended to a week or more.

9.5 Asphalt Primer, Code D, shall be high-grade asphalt cut-back priming paint with good penetration and a bond for Classes 1 and 2 insulation, and good bond for metals and asphalt plastic.

9.6 Asbestos Roofing Felt, Code E, shall be good quality asbestos felt jacket weighing not less than 45 pounds per square and otherwise meeting ASTM Specification D250. The felt shall be saturated and coated on both sides with an asphalt having a softening temperature of not less than 185°F.

9.7 Bands shall be metal strips suitable for bending around insulated piping or equipment and securing by crimping or clasping in place. See Table IV, Appendix A, for Material and Size specification.

9.8 Band Seals are metal fasteners attached to bands with a banding tool to secure bands in place. They shall be of the same material as the bands. The manufacturer of the banding tool usually makes band seals to suit the tool of his manufacture.

9.9 Clips, wire or band, are small pices of metal that are welded to the surface to be insulated, and are used to secure wires or bands holding the insulation.

9.10 Fibrous Adhesive, Code F, is a thick, gummy, silicate-cement-base material having some asbestos fibers mixed with it. It must adhere permanently to any surface in the temperature range of 200° to 1800°F. It is particularly advantageous in cases where large temperature changes occur frequently and where it is difficult to secure insulation in place; e.g., on flat surfaces of equipment which face downward. Insulation shall be wired or banded in place in the same manner, whether fibrous adhesive is used or not. Paint must be removed from surfaces to which fibrous adhesive is to be applied.

9.11 Finish Cement, Soft, Code G, shall be predominantly a long-fibered asbestos cement together with a heat-resisting binder, and shall meet ASTM Specification C-194-44T. This material can be given a hard surface by troweling or smoothing. It may be used on insulation where the surface to be insulated is in continuous service over 200°F and where water will not come in contact with the cement. The amount of water to be used in mixing is 21 gallons or 175 pounds per 100 pounds of cement.

9.12 Finish Cement, Hard, Code H, shall be a mixture of soft-finish cement, Code G, and a portland cement in the ratio 1 to 3 by weight or 1 to 12 by volume. The cement shall be mixed in small batches and shall not be tempered. This cement may be used indoors as follows:

9.12.1 Over insulation with service temperature under 200°F.

9.12.2 Where small amounts of liquids may spatter on insulation.

9.12.3 Where insulation is not in continuous service.

9.12.4 As intermediate between low-temperature insulation and a hot surface; e.g., a steam line entering low- or dual-temperature equipment.

The amount of water to be used in mixing is 21 gallons or 175 pounds per 100 pounds of cement.

9.13 Insulating Cement, Code J, shall be composed predominantly of mineral wool and shall meet ASTM Specification C-195-45-T, except that the thermal conductivity at 500°F shall not be more than 0.80 Btu/hr sq ft °F/in. Further, the cement shall show no corrosion on steel and, when applied to a smooth steel surface, shall have a minimum adhesion when dry of 4 pounds per sq in. At operating temperatures of 1200°F, the dried cement shall not powder, check, or crack. Cement shall be applied in layers 3/4 inch thick or less. The amount of water to be used in mixing is 30 gallons or 250 pounds per 100 pounds of cement.

9.14 Lagging Cement, Code Y, shall be prepared from polyvinyl acetate emulsion and shall be suitable for cementing canvas to insulation and to itself. This material shall have high bond strength, be resistant to vermin and mold, and shall be durable. The adhesive shall contain 0.4% of Milban D as the mold inhibiter based on the total weight of the adhesive. The adhesive shall increase the fire resistance of canvas on which it is applied.

9.15 Mesh Screen, 2 x 2 Hardware Cloth, shall be No. 19 gauge 1/2-inch square mesh galvanized iron wire.

9.16 Mesh Wire shall be zinc-coated, galvanized iron or steel hexogonal mesh wire for use on insulation. The openings of the mesh shall be 1 inch nominal. The size of the wire used in manufacture shall be not less than 0.049 inch, that is, 18 gauge. The weight of zinc coating on mesh wire shall not be less than 0.7 ounce per sq ft of uncoated wire surface. The zinc coating shall adhere firmly to the wire and shall be considered as meeting this requirement if, due to bending over the 0.049-inch wire, it does not flake and none of the coating can be removed from the wire by rubbing with the bare fingers.

9.17 Metal Lath shall be expanded steel lath with a protective coating of rust-resisting paint, in accordance with Federal Specification No. QQB-101C, Types F, SF, or FR. Its weight shall not be less than 2-1/2 pounds per sq yd.

9.18 Paraffin as referred to herein shall be commercial paraffin having a melting point of not less than 125°F. It is to be poured at 160°F.

9.19 Pasted Canvas Drilling, supplied with pipe insulation up to 6-inch pipe size and that which is supplied separately, is known to the trade as 3.8-ounce canvas. This is lightweight canvas of about 3.8 ounces per sq yd and has a warp count of 60, plus or minus 5, and filler count of 30, plus or minus 4. Lagging cement shall be used to seal the canvas laps.

9.20 Cemented Canvas shall be 8-ounce canvas cemented in place with lagging cement. This canvas weighs approximately 8 ounces per sq yd and has a warp count of 84, plus or minus 5, and a filler count of 28, plus or minus 1.

9.21 Rib Lath shall be metal lath with either integral or separately attached stiffening members, in accordance with Federal Specification No. QQB-101C, Types F3/8R or F3/4R. The weight of rib lath shall not be less than 3 pounds per sq yd for 3/8-inch rib lath or 4.5 pounds per sq yd for 3/4-inch rib lath.

9.22 Rosin-Sized Paper shall be rosin-sized sheathing paper, weighing 40 pounds per roll of 500 sq ft. When applied under 8-ounce canvas, the ends shall be well feathered and the edges lapped at least 2 inches.

9.23 Sealing Tape shall be rubberized canvas tape commonly known as friction tape. For insulation it is generally used in 3-inch or 4-inch widths and shall meet ASTM Specification D-69.

9.24 Seam Filler, Code K, shall be a compound of asphalt, pitch, asbestos fiber, and a solvent of such consistency as to be suitable for filling chipped edges and small joints. Seam filler shall not become brittle in service. Brine putty shall not be used.

9.25 Severe Service Paint, Code O, shall be paint which, when dry, will form a tough, flexible, weather-resistant finish. It shall form a permanent vapor seal and be suitable for service from minus 180°F to plus 600°F.

9.26 Skewers are pins of wood, sharp on one end, used on tank heads

and similar places to fasten the additional layers of cork insulation to the cork already applied.

9.27 Twine shall be 3- or 4-ply jute twine. This should be furnished in 1/4- or 1/2-pound spools.

9.28 Vapor Seal Plastic, Code S, shall be asphalt plastic material of uniform quality, cut-back with a solvent to spraying consistency. The product shall not flow, sag, check, or crack over a temperature range of minus 40°F to plus 300°F, and shall not absorb moisture. The material shall bond securely to metal, asphalt, cloth, wood, paint, clean and dry concrete, and various insulating materials to which it is applied. It shall be fire-resistant, and shall be suitable for application cold in film thicknesses up to 3/16 inch.

This material shall form a durable elastic vapor seal which is acid, alkali, and weather resistant.

The water-vapor permeability of 1/8-inch-thick coating of this material shall not be over .0015 ounce (.66 grain) per sq ft per 24 hours under a vapor-pressure differential of 11.9 millimeters of mercury at 25°C.

Application by spraying is recommended, using spray equipment specified by the manufacturer of the asphalt plastic. However, asphalt plastics may be troweled on for maintenance work or valves and fittings, where this may be done more economically. Where considerable troweling work is to be done, troweling-consistency asphalt plastic should be used in order to facilitate application.

9.29 Water-Resistant Cement, Code P, shall be a nonasphaltic stiff adhesive effective over a temperature range of minus 180°F to plus 300°F. It is used to bond low-temperature insulation, that is, cork or impregnated mineral wool, to steel and to itself. In addition to bonding the insulation, its function is to provide a lasting water and vapor barrier between blocks of the insulation so that a water or moisture leak in the finish at one point will not permeate the entire insulation. A permanent elasticity in the cement is required to follow the expansions, strains, and flexing of equipment insulation over the temperature range.

Water-resistant cement shall be of troweling consistency and shall be applied so as to have ridges in it such as would result from the use of a notched trowel. The resulting surface film with cement is readily broken when placing the insulation in place and a better bond is obtained.

9.30 Weather-Resisting Paint, Code W, shall be a paint which will bond well to metals, insulating materials, and finishes. This coating shall be tough, elastic, and durable. It shall provide protection against weather and mildly corrosive conditions.

9.31 Window Screen shall be No. 12 mesh, enameled or galvanized iron screen.

9.32 Wire material and size shall be as specified in Table IV, Appendix A.

9.33 Vapor-Seal Paint, Code X, shall consist of an asphalt-base vehicle to which has been added aluminum flake in a proportion

that will result in the aluminum flaking-out on the surface to give an aluminum finish. Aluminum flake shall comply with ASTM Specification 266, Grade A. A minimum of 2 pounds of aluminum flake per gallon of paint is recommended. This paint, when dry, shall provide a tough, durable, weather-resistant finish. It shall form a permanent vapor seal and shall be suitable for a temperature range of minus 180° to plus 250°F.

9.34 Fiberglas Padding, Code T, shall be composed predominately of glass in the form of a blanket held together by means of a bakelite binder. It is commercially available in thicknesses of 1/2-inch and 1-inch. This material will change from red-brown at room temperature to a fluffy white material at 700°F due to the binder burning out at these temperatures. The absence of the binder, however, has no effect on its insulating efficiency. This material, when placed between layers of asbestos or Fiberglas cloth, is used as a cushion or seal where tight joints are required with rigid insulation, especially on joints of high-temperature premolded covers.

9.35 Asbestos Cloth, Code U, shall be 95% asbestos fibers approximately 2.4 pounds per sq yd, with a warp count of 12 and a filler count of 12. The minimum thickness shall be 0.055 inch and the temperature limit, 850°F. Commercial-grade asbestos cloth shall be 80% asbestos, approximately 2.3 pounds per sq yd, with a warp count of 10 and a filler count of not less than 10. The minimum thickness shall be 0.058 inch, and the temperature limit, 350°F.

INSULATION AUXILIARIES

TABLE VIII

| Term | Code Number | Product Designation and Key to Manufacturer(See following page) |
|---|---|---|
| Asphalt Cement | A | Laptite (JI) No. 299(A4) |
| Asphalt, Cut-Back Plastic, or Flashing | B | Insul-Mastic No. 507(I1) |
| Breathing Plastic | C | OC Mastic No. 90-7 (B2)<br>Thermotex BX (C2) |
| Asphalt Primer | D | Gilsonite Primer 4132 (I1)<br>Carbozite Primer (C1) |
| Asbestos Roofing Felt | E | Double-Coated Flexstone (J1)<br>45-lb Asbestos Base Sheet (C2) |
| Fibrous Adhesive | F | Fibrous Adhesive (J1),(C2),(E2),(B2) |
| Finish Cement (Soft) | G | No. 302 (J1), No. 707 (C2), Bell Asbestos (A4), No. 99 (E1) |
| Finish Cement (Hard) | H | Products listed in Code G plus portland cement |
| Insulating Cement | J | No. 450 (J1), No. 66 (E1), No. 1 (B1), No. 18 Heat Seal (E2), No. 2-4-1 spec. (W2) |
| Seam Filler | K | Uniseal (J1), Seam Filler (A4), Seam Sealer (B2) |
| Severe Service Paint | C | Carbozite No. 56-3 (C1) |
| Water-Resistant Cement | P | No. 236 (A4), No. EC-391 (M1), No. 81-33 (B2),Type MT & M (M3) |
| Vaper-Seal Plastic | S | Insul-Mastic No. 4010 Spraying (I1) |
| Fiberglas Padding | T | Mfr. Code H-33 (02) |
| Asbestos Cloth | U | Commercial (C2), Style No. 912 & 1067 (J1), Style No. 860 & 880 (U1) |
| Weather-Resistant Paint | W | Bituplastic No. 28-Z (W1) |
| Vaper-Seal Paint | X | Carbozite Std. Black Plus Al (C1)<br>Flintkote Al Paint, Ready Mixed (F1)<br>Gilsonite Al Spray No. 4604-E (I1) |
| Lagging Cement | Y | Lagging Cement No. 81-42W (B2), No. 70-86-03 (A3) |

The above list covers known acceptable products and does not exclude equivalent products of equal characteristics and quality.

TABLE IX

KEY TO MANUFACTURER'S OF INSULATION AUXILIARIES

| Key Number | Manufacturer's Name | Address |
|---|---|---|
| A3 | Arabol Manufacturing Co. | New York, New York |
| A4 | Armstrong Cork Co. | Lancaster, Pennsylvania |
| B1 | Baldwin Hill Co. | Trenton, New Jersey |
| B2 | Benjamin Foster Co. | Philadelphia, Penn. |
| C1 | Carbozite Protective Coatings, Inc. | Pittsburgh, Pennsylvania |
| C2 | Carey Manufacturing Co. | Cincinnati, Ohio |
| E1 | Eagle-Picher Sales Co. | Cincinnati, Ohio |
| E2 | Ehret Magnesia Manufacturing Co. | Valley Forge, Penn. |
| F1 | Flintkote Co. | Philadelphia, Penn. |
| I1 | Insul-Mastic Corp. of America | Pittsburgh, Pennsylvania |
| J1 | Johns-Manville Sales Corporation | New York, New York |
| M1 | Minnesota Mining and Mfg. Co. | St. Paul, Minnesota |
| M3 | Miracle Adhesives Corporation | Newark, New Jersey |
| O2 | Owens-Illinois Glass Co. | Toledo, Ohio |
| U1 | Union Asbestos and Rubber Co. | Cicero, Illinois |
| W1 | Koppers Company, Inc. | Westfield, New Jersey |
| W2 | Weber Insulations, Inc. | East Chicago, Indiana |

Note: This is only for information and identification of symbols used on preceding table.

## SECTION D

## APPLICATION

1.0 QUALITY OF MATERIALS AND WORKMANSHIP

1.1 All insulation being installed shall be in new condition and shall meet the required material specifications as set forth in Section C. All insulation shall be installed in a workmanlike manner and as hereinafter specifically directed.

2.0 SURFACE PREPARATION AND PAINTING

2.1 The persons responsible for the erection of equipment, ducts, or piping shall be required by the Owner to complete such work in a condition ready for the application of insulating materials. The Contractor shall report the presence of water, dirt, oil, or loose scale to the Owner's Representative before applying any materials.

2.2 Painting of bare pipes or equipment prior to insulating is not included as a part of the work to be done under this specification.

Application of insulation auxiliary materials by the use of a painter's brush or similar means shall not be construed as painting in the above sense.

3.0 FIT OF INSULATION

3.1 All insulation shall be of uniform thickness for each pipe size and for equipment as designated, and, unless otherwise specified, shall fit snugly the surface to which it is applied.

Block or molded insulation shall be scored where necessary to make it conform to the surface being insulated. All pipe covering shall be applied with the joints tightly butted together. Any insulation that does not fit properly shall be removed and replaced with suitable insulation.

Some void spaces shall be permitted on high-temperature lines in such cases as fitting covers, flange connections on equipment, and steam-chased lines, but void spaces are to be kept at a minimum. No void spaces shall be permitted on low temperature equipment. All spaces in flange, valve, and fitting covers shall be completely filled with insulation.

4.0 FLASHING

4.1 A very thorough flashing job shall be provided wherever insulation is to be made weatherproof. At intersections in the finish, piers, nozzles, building walls, valve bonnets, supports, hangers, and other parts protruding through the surface of the finish, asphalt cut-back plastic (Code B) shall be applied as a flashing or water shed. This shall be a 1/4-inch thick coating extending several inches over all intersecting surfaces.

5.0 BANDING AND COVERS

5.1 Insulation on flanges, valves, and fittings shall be held in place by the same size wire or bands as used on adjacent pipe covering.

5.2 Insulation thickness over flanges shall be equal to that used on the adjacent pipe, unless otherwise specified.

5.3 Covers shall be applied over flanges, valves, and fittings in accordance with Figures 10, 11, 13, and 14, Appendix B.

5.4 All bands shall be held by double-clasp-type sealers, using commercial tools for stretching bands tight.

6.0 INSULATION AND STEAM-CHASED LINES

6.1 Pipe covering on steam-chased lines shall be sized large enough to enclose both the pipe line and chaser, yet fit as snugly as possible (See Fig. 20.) Steam-chaser expansion loops shall be covered with pipe covering, securely wired in place, and finished to suit service requirements.

7.0 PIPE COVERING AT FLANGES, VALVES, AND FITTINGS

7.1 Pipe covering shall be stopped off a sufficient distance from all flanges to permit easy removal of the bolts. Sufficient time shall be allowed for complete drying-out of insulation and cement at flanges or openings in insulation before sealing them up.

7.2 The Contractor shall insure that lines which will operate at temperatures of less than 100°F are tested before insulation is applied, then the entire line shall be fully insulated and insulation made vapor-tight before reducing its temperature below that of the surrounding atmosphere. Flanges and flanged fittings shall not be covered kntil they have been tested and approved as being ready for insulating by the Owner's Representative.

7.3 High-temperature lines operating at temperatures from 100°F to 600°F shall be hydrostatically tested and approved by the

Owner's Representative as ready for insulating of only the pipe line before any insulation is applied to the line. When approval is given to insulate the pipe line, the Contractor shall insulate the pipe line only, leaving flanges and flanged fittings uninsulated until the Owner's Representative has had a reasonable time in which to steam test the line at the working temperature and pressure, correct all leaks in the system, and give approval to proceed with insulating the flanges and flanged fittings.

7.4 Pipe ends shall be completely covered by the same thickness and finished the same as the adjacent insulation.

8.0 PIPE HANGERS

8.1 Where pipe hangers are attached directly to the pipe by clamps, the clamps shall be covered with the pipe covering; removing, when necessary, part of the inside surface of the insulation, to maintain the continuous unbroken outer surface of the pipe covering. The insulation around the hanger clamp shall be sealed with finish cement, as shown in Figure 12, Appendix B, and where weatherproof finish is required, this shall be carefully flashed.

8.2 On refrigerated lines where the hanger rods are welded to the pipe, insulation shall be installed as in Figure 28, Appendix B. The hanger rod, or lug, shall be insulated for the distances shown in this figure.

8.3 Where hanger clamps are placed over the pipe covering as on refrigerated lines, the insulation shall be installed as shown in Figure 24. The covering under the hanger clamps shall be protected by a piece of asbestos roofing felt overlapping a

metal shield of galvanized iron or aluminum.

8.4 Where blanket-type hair felt or mineral wool is applied, the hanger rods shall be painted with vapor-seal paint (Code X), wrapped with tape, and the tape painted in the same manner as the pipe covering. The minimum distances for which the hanger rods must be insulated are given in Figure 28. Distances given are suitable for a service temperature range of -180° to 32°F.

The hanger rods shall be insulated with three layers of hair felt tapering off to one layer at the upper end; the first layer shall cover 1/3 of the above distance, the second layer 2/3 of the distance, and the third the total distance insulated. Each layer shall have the felt fit tightly and shall be secured in place with wraps of twine not over one inch apart. Sealing tape shall be wound on each layer of felt spirally starting at the bottom so that at no point will there be less than two plies. Each layer of sealing tape shall be painted with a coat of vapor-seal paint. The sealing tape shall extend over the adjacent pipe covering and the hanger rod and shall be sealed to it with asphalt cut-back plastic. (See Figure 28)

9.0 COVER DIMENSIONS

9.1 Cover lengths for line flanges covered with standard-thickness insulation are established on the basis of removing bolts or studs from one side of the flange only. For example, the cover length for a 4-inch 150 lb line flange was arrived at as follows:

Distance over flanges = 2 x 15/16" + gasket = 2"

Length of stud bolts = $3\frac{1}{2}$"

Projection of stud on back side $(3\frac{1}{2}-2)/2$ = 3/4"

Insulation lap = 2 x 2" (minimum) = 4"

Calculated total = 10+ 1/4"

Nominal length (next larger whole number) = 11"

9.2 Cover lengths for line flanges covered with insulation thicker than standard thickness (magnesia) shall be determined in the same manner illustrated above, lapping the flange cover over the pipe covering for a distance equal to the thickness of the pipe covering, but not less than 2-inches per lap.

9.3 Cover lengths for valves and fittings shall be not less than the sum of the following measurements: (See Figures 10, 11, 13, and 14)

Face-to-face of valve or fitting.

Allowance for bold or stud removal.

One-inch additional bolt clearance for each joint included.

Allowance for laps of cover over the pipe covering for a distance equal to the thickness of the pipe covering at each lap, but not less than 2-inches per lap.

10.0 GENERAL PRECAUTIONS

10.1 Wherever personnel might contact piping with exposed wire bands, the crimps and wire twists shall be located away from the aisle as a safety measure.

10.2 Safety precautions must be observed in handling asphalt plastic, asphalt cut-back plastic, asphalt primer, and all other materials containing an inflammable solvent as received in the manufacturer's shipping containers. Even

greater precautions must be observed where petroleum distillates may be required and used for cutting and thinning paints or coatings specified herein. Napthalene shall not be used because of its great hazard. The following materials are suggested, with the highest-flash-point material preferred:

Varsol #1 (Flash point 175°F.)

Stoddard Solvent (Flash point 103°F.)

Varsol #2 (Flash point 102°F.)

10.3 It is very important that no paint or plastic finish of any kind be applied over insulating or finish cement until such cement is thoroughly dry.

10.4 Where new cement is to be applied over existing cement, the outside surface of the existing cement shall be thoroughly wet before applying the additional coat.

10.5 All insulation on equipment which will be at or below 32°F must be sealed with a vaporproof finish to prevent moisture penetration.

10.6 In applying asphalt plastic, asphalt cut-back plastic, or a finish coat of paint, the coating or surface on which it is applied must be free from moisture, oil, dirt, or other foreign material.

10.7 Where Type E or F finish is used on hot work, it is important that all plastics be permitted to dry thoroughly before putting the piping or equipment into service so as to prevent blistering.

11.0 MOLDED INSULATION - PIPE, VALVES, FITTINGS, AND EQUIPMENT

11.1 This specification is for the following pipe covering and block insulation:

| Code | Material | Temperature Range °F |
|---|---|---|
| 1A | 85% Magnesia | 70 to 550 |
| 1B | Spun Glass | 70 to 600 |
| 1C | Felted Laminated Asbestos | 70 to 500 |

11.2 All pipe covering shall fit snugly on the pipe to which it is applied. Inside circumference of pipe covering when applied shall not vary from the outside circumference of steel pipe, as given in A.S.A. Specification B 36.10, by more than the following amounts:

| Nominal Pipe Size, In. | Permissible Variation in Inside Circumference | |
|---|---|---|
| | Over | Under |
| 1/8 to 5 inclusive | 0.0 | 0.125 in. |
| 6 to 12 inclusive | 0.0 | 2% |

Where expansion joints are to be used the inside diameter of the pipe covering shall be not less than 1/16" nor more than 1/8" oversize.

All double-layer insulation shall have the lateral and longitudinal joints of the second layer staggered with those of the first layer. No canvas is to be used between layers. All joints on both layers shall be "mudded in."

For pipe covering to be finished with Type A or AA Finish (pasted canvas), the covering shall be secured to the pipe underneath the canvas with one loop of wire at each end. On pipes larger than 4" OD, the insulation shall be applied without canvas jackets and secured with four loops of wire per section. The ends of the wire loops shall be tightly twisted three times, and hammered into the insulation so

as to leave no projections.

For pipe covering installed with Type F Finish (asbestos felt jacket), or Type J Finish (cemented canvas), each section of the insulation shall be secured to the pipe with no less than four separate loops of wire twisted three times, bent over, and hammered into the insulation. Lateral joints shall be staggered.

Molded sectional pipe covering is preferred for all pipe sizes. However, where segmental pipe covering is used (pipe sizes 12" and over), it shall be held in place with four bands per section, with alternate lateral joints staggered. On single-thickness segmental covering, insulation at joints shall be butted tightly for the full thickness of the insulation block. Occasional joints which do not fit tight shall be fully closed by tamping the insulation on each side of the joint or "mudding" the joint.

Small voids or holes up to 1" square in the insulation, such as a broken corner, shall be filled with insulating material or with insulating cement.

11.3 The application of insulation on flanges and on flanged fittings and valves is illustrated in Figures 10, 11, 13, and 14, Appendix B. Block insulation, or pipe covering, shall be applied over the body of a valve or fitting between flanges, of sufficient thickness to make the OD over this insulation equal to the OD of the adjacent flanges. Cover shall be applied over this, consisting of a single layer of pipe covering or block

insulation, extending across and overlapping the adjacent pipe covering at least 2". Insulating cement may be used to hold insulation prior to wiring in place. The outside of the insulation on fittings shall be given a troweled coat of finish cement to present a smooth surface.

11.4 Screwed and welded fittings and valves (up to the bonnet), on 4" pipe and larger, shall be insulated with block insulation or pipe covering. (See Fig. 13 and 14). On pipe sizes less than 4", the screwed and welded fittings and valves shall be covered with insulating cement instead of pipe covering or block insulation, with the minimum thickness equal to that of the adjacent pipe insulation. (See Figure 15.)

11.5 Equipment shall be covered with blocks or curved segments in one layer for thicknesses of 2-1/2" or less and two layers for thickness of 3" or more. The insulation shall be applied with joints staggered and tightly butted together.

Fibrous adhesive may be used to facilitate installation of insulation or horizontal surfaces facing downward.

Insulation around nozzles or openings shall be held in place by wires or bands secured to a floating ring or to clips set back 3" from the nozzles or openings. (See Figure 16.)

11.6 The heads of cylindrical equipment shall be insulated first, securing tie wires on 4" centers or less to clips, angle-iron bands, or steel bands around the circumference of the tank behind the rivet heads or the head weld. (See Figure 16.)

Insulation on the heads of horizontal tanks shall be held in place with wire fastened to clips or a floating ring at the center of each end of the tank. Clips are preferred to the floating ring or bands around the tank for securing the binding wire to the tank.

The insulation on the cylindrical sides of the tank shall have the joints staggered; i.e., alternate lengths in the first row around the tank shall be 18" and 36". Bands shall be placed approximately 1" from the ends of the block insulation, thus providing four bands for each 36" length of insulation.

Spaces in the insulation greater than 1" across shall be filled with the block insulation wired in place while smaller spaces may be filled with insulating cement.

Flanges on equipment in many cases may be left bare; however, where insulation is specified, covers shall be installed. Blocks shall be applied over the equipment flanges, extending 3" over the adjacent insulation on the cylindrical sides of the equipment. (See Figure 16).

11.7 The insulation on square-cornered equipment such as ducts, dryers, etc., shall be applied with bands in a similar manner to that used for cylindrical equipment. Over the flat surfaces, the bands shall be fastened to clips on the surface by wires at 24" intervals on vertical surfaces, and 12" intervals on horizontal surfaces facing downward.

Where the insulation is applied on vertical sides only and bands cannot be applied, wire shall be used. Clips shall be provided at 6" intervals around the bottom and top and at intermediate points on the surface so that the wires can be tied to the surface at intervals of 24" or less.

Welded or cemented studs or pins may be used in place of wire or bands to secure insulation to flat surfaces. Studs or pins shall be Nelson-type welded studs, or approved equal; or an approved adhesive-type pin cemented in place with Miracle Adhesive Type M, or approved equal. Welded studs shall not be used on steel surfaces lighter than 16 gage or on aluminum surfaces. When used, the insulation shall be secured with studs or pins at each corner, and along each edge of each piece of insulation at intervals of not less than 12", and over the surface of each piece of insulation at intervals of not less than 18" measured in two directions.

Angle supports shall be placed under bands and wires at the edges of equipment to prevent cutting the insulation.

## 12.0 CLASS 2 - CELLULAR INSULATION OF PIPES, VALVES, FITTINGS, AND EQUIPMENT

12.1 This specification is for corrugated-asbestos (Code 2A) pipe covering and block insulation for temperatures from 70°F to 300°F.

Caution must be used in installing this insulation to see that the cells are not crushed or damaged, especially when wiring or banding in place.

12.2 Pipe covering with Type A and AA Finish shall be applied with five copper staples per section and the canvas lap pasted tightly over the staples, turning the edge of the lap to the least visible side of the pipe. (See Figure 8.) Staple sizes shall be 3/4" for 1" pipe covering and smaller, 1" for pipe covering between 1" and 6", and 1-1/2" for pipe covering over 6". Exposed ends shall be filled with soft finish cement before applying the insulation to the pipe. Pipe covering to be finished with Type F Finish shall be applied and secured in place with five loops of wire or bands per section, as shown in Figure 9.

12.3 Unless otherwise specified on the drawings, flanges, valves, and fittings in lines insulated with corrugated-asbestos (Code 2A) shall be covered with insulating cement to the same thickness as that of the adjacent pipe covering, as shown in Figure 15, Appendix B.

12.4 Cellular insulation shall be applied on cylindrical and square-cornered equipment in the same manner as is given for molded insulation (Code 1A, 1B, or 1C). Fibrous adhesive may be used on vertical surfaces and horizontal surfaces facing downward. Flanges on equipment shall be left bare, except where covers are specified.

13.0 BLANKET INSULATION ON EQUIPMENT

13.1 This specification is for Mineral-Wool Insulations (Code 4A) consisting of blankets furnished with window-screen, mesh-screen, metal-lath, hexagonal-mesh-wire, or rib-lath backing.

13.2 Blanket insulation on equpiment shall be applied with the metal lath or heavy mesh outward and shall be secured in place by means of angle-iron bands, studs, 5/32"-diameter welding wire, or bands as hereinafter specified. Outer metal backings shall have all joints laced together with wire at 6" intervals. Blanket insulation on flat surfaces may be secured with welded or cemented pins, as described for Class 1 insulation.

The insulation on cleanout doors and adjacent to openings shall have the metal lath bent at right angles to meet the equipment surface.

13.3 On curved equipment, other than cylindrical, the preferred method of holding the blanket in place is by means of studs or welding rods welded to the surface of the equipment on 6" centers as illustrated in Figure 18, Appendix B.

On cylindrical equipment, heads shall be insulated first, then the cylindrical portion. Bands shall be pulled tight over the insulated cylinder at intervals of two feet or less to prevent sagging. (See Figure 18.) Where a vertical cylinder eight feet or more in height is involved, an angle-iron band shall be installed above the lower head in order to support the insulation on the vertical sides of the equipment.

## 14.0 LOW-TEMPERATURE FORMED INSULATION - PIPE, VALVES, FITTINGS, AND EQUIPMENT

14.1 This specification is for low-temperature formed insulation,

Cork (Code 6A), to be used on pipe, valves, fittings, and equipment. Before insulation is applied, it is important that surfaces be prepared as described in paragraphs 1.0 - 10.0, Section D. After insulating, all voids shall be filled.

14.2 Cork pipe covering shall have a factory coating of heavy mastic to provide an effective seal against air and moisture infiltration. Pipe covering shall be applied in a single layer with longitudinal joints on the top and bottom of the pipe. End joints shall be staggered by making one-half of the first section 18" long.

The insulation shall be applied to the pipe, using asphalt cement on all longitudinal and circumferential joints, and held in place with not less than six loops of wire or bands per section. All wires and bands shall be drawn tight around the covering and pressed against the surface, but not breaking the surface seal.

The ends of the pipe covering at flanges shall be given a coat of asphalt cut-back plastic to seal the covering to the pipe.

14.3 Flanges, valves, and fittings shall be insulated with molded cork covers or with built-up covering of cork board. The choice between molded cork covers and built-up covering of cork board shall be made on the basis of cost. For small pipe sizes (4" and under), the molded covers are generally cheaper, while for larger pipe sizes the built-up covering is generally less expensive. (Figures 21, 22, and 23.)

The built-up covering of cork-board material shall not be less than the thickness of the adjacent pipe covering and the pieces of cork board shall be held together with asphalt cement and skewers. The built-up covering shall be made in sections so as to be readily applied over flanges, fittings, or valves and shall fit with a minimum of void spaces. The flange covering shall extend at least 3" over the adjacent pipe covering.

The molded and built-up covers shall be held in place with asphalt cement on all joints. Wires and bands shall be drawn tight around the fittings and pressed into the surface. Flashing shall be applied as needed. When molded covers for welding fittings are ordered, the name of the manufacturer supplying welding fittings should be stated.

14.4 Equipment shall be insulated with lags or segments cut from blocks or sheets of the insulation.

On flat or cylindrical surfaces, insulation 4" thick or less shall be a single lay and for thickness greater than 4" shall be two or more layers.

The insulation shall be applied on surfaces with asphalt-cement coating both the metal surface and all contact sides of the lags in order to provide a vapor-seal barrier around each lag.

The heads of cylindrical equipment shall have insulation applied in two courses. Each course shall be pressed into

place to secure a good bond. The first course shall follow the curve of the head and the sides to a point where angle-iron band or clips may be located. (See Figure 25.) For all tank bottoms and heads of tanks, clips or angle-iron bands shall be installed to furnish support for tying insulation to the tank. (See Tables III and IV in Appendix A.)

Where lagging on the head meets the lagging on the sides of the curved tank, the side lagging is to be cut in such a manner as will provide an offset or broken joint. The first course on the head is to be held in place with wires attached to the clips or angle-iron bands around the circumference of the tank behind the rivet heads or the head weld, and by a floating ring or clips at the center of the head. The second course is to be cemented, and skewered-to in the case of cork, the first course following the curve of the head. This shall then be wired in place in the same manner as the first course, except that wires will be attached to a floating ring at the center of the head, and to a band around the tank insulation. (See Figure 25.)

The sides of round tanks shall have lags installed in single thickness, applied with water-resistant cement on all joints, and held in place with no less than six bands per 36" section. The joints of the insulation shall be broken by using 18" blocks in alternate rows of the first course. The bands should be placed about 1" from the end joint, and one band in the center of each 18" space.

The insulation over manhole covers, heat-exchanger heads, openings for inspection of ASME code markings on pressure vessels, and other surfaces as indicated in the drawings, shall be so applied as to permit removal and replacement of the covers and heads without damage to the insulation. The design of the cover and head insulation shall be submitted for approval by the Contractor to the Owner's Representative before any insulation is applied.

All wires or bands connected to equipment being insulated shall be covered with insulation.

14.5 Nonweatherproof insulation on pipe, valves, flanges, and fittings snall have Type G or GG Finish.

Weatherproof insulation on pipe, valves, flanges, and fittings shall have Type F Finish.

Insulation on equipment shall have Type EE Finish.

15.0 FELT INSULATION ON PIPE, VALVES, FITTINGS, AND EQUIPMENT

15.1 This specification is intended for felt insulation for service temperatures below the dew point of the surrounding air. The insulants considered in this class are as follows:

| Code | Materials | Temperature Range $^{o}F$ |
|---|---|---|
| 8A | Hairfelt | -180 to 160 |
| 6C | *Mineral-Wool Felt | -180 to 160 |

The felt insulation shall be applied in the number of plies specified and after application each ply shall be approximately 3/4" thick.

*For use on Flanges, Valves, and Fittings only.

15.2 The pipe shall be painted with one coat of vapor-seal paint for a distance of approximately 12" from each flange. After the paint is dry, sealing tape shall be wound over it spirally so that at no point are there less than two plies. The tape shall be given a coat of vapor-seal paint to seal the edges.

The pipe shall then be wrapped with a layer of 1" felt cut to proper length so that the felt shall fit close to the pipe and all longitudinal and abutting joints shall fit closely together. Second and subsequent layers of felt shall be applied with joints broken. Each layer shall be held in place with twine wound spirally over the felt on approximately 1" centers.

Over each of the last two layers of felt there shall be applied a protective vapor seal of tape wound on spirally so that at no point are there less than two plies. Each two plies of tape shall be given a coat of vapor-seal paint (Code X) to seal the edges of the tape.

Felt insulation on piping shall be sectionalized by sealing the tape forming the inner vapor seal to the pipe and the outer vapor-seal tape to the inner vapor seal. The two seals shall be staggered. This arrangement is to localize damage to the insulation, should failure of a vapor seal occur at some point. Maximum sealed length of insulation shall not exceed 12 feet.

The insulation shall be stopped at sufficient distance from

valves and fittings so that the sealing tape can be brought down to the pipe and sealed to it.

15.3 All flanges, valves, and fittings shall be insulated separately from the adjacent pipe covering. The insulation over the body of the valves and fittings shall be of the same thickness as on the adjacent pipe. As each ply is put on, it shall be secured in place with wraps of twine not over 1" apart. Over each of the last two layers of felt there shall be applied the protective vapor-seal tape, wound on spirally so that at no point are there less than two plies. The sealing tape shall extend over the adjacent pipe covering and shall be painted and sealed to the covering with vapor-seal paint. The junction of the sealing tape and any protruding metal, wood, etc., shall be carefully flashed (See Figure 27).

15.4 Weatherproof insulation on piping shall have Type F Finish or Type EE Finish.

16.0 ANTI-SWEAT INSULATION

16.1 Ground Cork and Asphalt (Code 7A) shall be applied on 5" and larger diameter pipe, and equipment, valves and fittings to prevent sweating of surfaces between $40^{\circ}$ and $75^{\circ}$F. When dry, the coating shall be 1/4" in thickness. It may be applied by troweling or spraying. Maximum thickness, in general, shall be 3/8".

16.2 Insulating Felt (Code 7B) shall be applied as a 1" thick covering on pipe lines up to 5" in diameter to prevent sweating of surfaces between $40^{\circ}$ and $75^{\circ}$F. The jacket shall be

lifted from both ends of each 3-foot section and the covering secured to the pipe with one loop of wire at each end, as illustrated in Figure 1, Appendix B. The canvas jacket shall then be pasted down at the edges.

17.0 FILL INSULATION

17.1 Fill materials are for use at the following temperatures:

| Code | Material | Temperature Range °F |
|---|---|---|
| (Auxiliary) | Cork Dust and Paraffin | -180 to 100 |
| 10A | Cork Dust | -180 to 250 |
| 10B | Mineral Wool - Granulated | -180 to 1200 |

On all applications where operating temperature of surface insulated will be below dew point, container or casing-enclosing fill material must be made vapor-tight.

Fill materials are used for two purposes:

1. To fill voids in flange, valve, and fitting insulations for low temperatures. (See Figures 21 and 23.)
2. To serve as insulation where specified, e.g., panel fill, to surround items otherwise difficult to insulate, etc. (See Figure 29.)

When installing fill materials, it is important that all voids be eliminated. This may be accomplished by tamping, rodding, vibrating, etc.

If the temperature of the surface insulated will at no time exceed 100°F, cork dust and paraffin are normally used to fill voids in fittings and equipment where the fill material can be poured into the cavity in the insulation. Above 100°F cork dust alone shall be used.

For low temperatures, surface imperfections, chipped edges, and small joints in cork or impregnated mineral-wool insulation on pipe and equipment shall be filled with seam filler, flashing, water-resistant cement, or vapor-seal plastic. However, seam filler (Code K) should not be used where air temperature surrounding equipment may be over $90^{\circ}F$.

## SECTION E

## FINISHES

1.0 TYPE A OR AA FINISH

1.1 Type A Finish shall consist of 3.8 ounce pasted canvas over Class 1 or 2 Insulation on pipe, flanges, valves, and fittings. The finish is nonweatherproof, for use indoores. (See Figures 1, 2, 5 and 8.)

1.2 Type AA Finish is Type A plus a brush coat of lagging cement over the entire outer surface of all canvas.

1.3 Pipe insulation shall be covered with pasted canvas having both longitudinal and circumferential laps. Lagging cement shall be used to seal the canvas laps, turning the lap, wherever possible, to the least visible side of the pipe. The ornamental brass or black bands usually supplied by the insulation manufacturer shall be installed with the fastening on the far side of the normal personnel approach to the pipeline.

1.4 Flanges, valves, fittings, and bends shall have a 1/4"-thick troweled coat of finish cement over the insulation. Over this shall be applied 3.8-ounce pasted canvas, cut to lap without wrinkles. For pipe sizes of 12" and larger, use Type D Finish plus the pasted canvas.

1.5 Where pipe lines are located indoors and operating at 300°F and over, the following precautions shall be taken to prevent burning of the canvas finish:

1.5.1 Where exposed fittings (uninsulated) are located in the line, the pasted-canvas finish applied to the line over the insulation shall be stopped at least 2" short of the end of the insulation.

1.5.2 Over the exposed insulation, cement asbestos cloth (See Type K Finish), with the ends of the asbestos cloth cemented neatly over the end of the pipe covering so as to cover the insulation completely, using lagging cement (Code Y).

2.0 TYPE D FINISH

2.1 Type D Finish shall consist of finish cement, either soft or hard as conditions warrant, and is nonweatherproof for indoors use.

2.2 Type D Finish may be applied on equipment, large valves, and fittings covered with insulation cement or Codes 1A, 1B, 1C, 2A, 4A insulation. The finish shall not be subject to acid spillage, excessive water, or high humidity.

2.3 Code 4A Insulation on equipment shall have one coat of asphalt paint applied over the insulation and wiring, plus two 1/4" coats of finish cement.

Classes 1 and 2 Insulation on equipment, valves, and fittings shall be finished with two 1/4" coats of finish cement. The first coat shall be applied rough and allowed to dry, then the second coat applied. The finished surface shall be smooth and free from checks or cracks. All equipment 12" OD and larger, as well as all valves and fittings of 12" pipe size and larger

shall have mesh wire to provide the base for this finish, drawn tightly over the insulation and secured to the clips, bands, and tie wires of the insulation.

3.0 TYPE E FINISH

3.1 This finish shall consist of Code C plastic plus suitable reinforcing and flashing to assure a weatherproof finish. It is to be used on equipment and bends, flanges, valves, and fittings outdoors where the equipment temperature is always above 70°F. It shall be applied as hereinafter specified.

3.2 Insulation on flat equipment shall be covered with mesh wire secured to the clips, bands, and tie wires of the insulation.

3.3 Insulation on curved equipment and large fittings shall be covered with mesh wire applied over the insulation, drawn in tight and securely laced.

3.4 Insulation and banding or wiring of Classes 1 and 2 shall be given one coat of asphalt primer (Code D) or weather-resistant paint (Code W) to improve the bond to be obtained between the insulation and finish.

3.5 After the above preparation, with exception of Code 4A, trowel over the entire outer surface of the insulation bands and wires two 1/4" coats of breathing plastic (Code C), allowing the first coat to dry and applying flashing (Code B), then applying the second coat of breathing plastic plus flashing (See Figure 15). As a final finish apply one coat of weather-resistant paint (Code W).

3.6 Insulation and wiring under Code 4A shall be given a 1/4" coat of insulating cement (Code J) which shall be allowed to dry.

One coat of asphalt primer (Code D) or weather-resistant paint (Code W) shall then be applied. After this preparation, trowel over the entire outer surface of the insulation, mesh, bands, and wires, a coating of breathing plastic (Code C) of 1/4" uniform thickness (16 to 20 gal/100 sq ft).

3.7 Support brackets on equipment which will operate above 300°F shall be covered with insulating cement to the same thickness as adjacent insulation with breathing plastic and flashing applied over this.

3.8 Where bare lines over 300°F pass through equipment insulation, insulating cement to the same thickness as adjacent insulation shall be applied to the line for a distance of several inches from the surface being insulated. Finish with breathing plastic and flashing to form a watershed as needed.

4.0 TYPE EE FINISH

4.1 This finish shall consist of Code S plastic plus suitable reinforcing and flashing to insure a weatherproof finish. It is to be used where equipment temperature is below 70°F all or part of the time.

4.2 Surface imperfections and small joints in insulation under Codes 6A, 6B, and 6C require sealing. No voids are to be permitted for any class of insulation on low-temperature work.

4.3 After the above preparation, the entire outer surface of the insulation, including bands and wires, shall be sprayed with vapor-seal plastic (Code S) to provide uniform protective coating of 1/8" minimum thickness using at least 8 gallon/100 sq ft. Flashing (Code B) shall then be applied as called for and as

per typical illustrations given in Figures 15, 21, 26, 27, and 28, Appendix B.

4.4 Where either Type E or EE Finish may come in contact with hot surfaces (over 300°F), a coat of severe service paint (Code O) shall be applied to the hot surface and the insulation both before and after applying the finish.

5.0 TYPE F FINISH

5.1 Type "F" Finish shall consist essentially of roofing felt over pipe insulation for all pipe sizes and asphalt plastic on flange, valve, and fitting covers up to and including 8" pipe size (See Type E Finish for 10" and over). This finish shall be used wherever a weatherproof finish is desired and shall be applied as hereinafter specified.

5.2 Code 4A insulation on bends, flanges, valves, and fittings shall be leveled by a 1/4" coat of finish cement and allowed to dry thoroughly.

5.3 Pipe covering shall be wrapped with 45-lb asbestos roofing-felt (Code E) jacket with at least 3" laps on the end and longitudinal joints. All laps shall be cemented with asphalt cement. The edge of the longitudinal flap shall be slightly above the horizontal centerline of the pipe. On outdoor pipelines the edge of the flap shall preferably be on the equator side of the pipe and so placed as to form a watershed. Where the outside diameter of the insulation is 10" or less, each section of the asbestos felt jacket shall be held in place with nine loops of wire, or not less than six bands (See Table IV, Appendix A). Where the outside diameter of the insulation is

over 10" each section of the asbestos felt jacket shall be held in place by not less than nine bands (See Table IV, Appendix A). Wire twists shall be bent down; twists and band seals shall be located directly over the horizontal flap seam.

5.4 Insulation on bends, flanges, valves, and fittings shall receive a priming coat of asphalt primer (Code D) or weather-resistant paint (Code W) followed by a plastic finish as follows:

| Where Equip. Temp. Will Be: | | No. of Coats | Wet Thickness of Each Coat | Plastic Finish |
|---|---|---|---|---|
| Above 70°F | | 2 | 1/4" | Breathing Plastic Code C |
| Below 70°F | part or all of the time | 1 | 1/8" | Vapor-seal Plastic Code S |

6.0 TYPE G OR GG FINISH

6.1 Type G or GG Finish shall consist of paint as hereinafter specified, and may be used on pipe, valves, flanges, and fittings covered with Code 6A, 6B, or 6C insulation where a non-weatherproof finish is required indoors. It shall consist of paint applied over the insulation as follows:

| Finish Code | Line Temp. °F | Paint | No. Coats |
|---|---|---|---|
| G | Above 70 | Weather-Resistant | One of Code W |
| G | 70 or less | Vaper-Seal | Two of Code X |
| GG | 70 or less | Vaper-Seal and Weather-Resistant | 2 coats X plus 1 coat W |

6.2 Type GG Finish should be specified and used where corrosive conditions may exist which would be detrimental to the aluminum in the vapor-seal (Code X) paint.

6.3 Code X paint shall be applied to a uniform thickness equivalent to coverage obtained in applying one gallon to 300 sq ft.

6.4 Code W paint shall be applied to a uniform thickness equivalent to coverage obtained in applying one gallon to 150 sq ft.

7.0 TYPE J OR JJ FINISH

7.1 Type J Finish shall consist of cemented canvas. It may be used on pipe, flanges, valves, fittings, and equipment covered with Code 1A, 1B, 1C, 1D, 2A, or 4A Insulation where a nonweather-proof indoor finish is desired.

7.2 Cemented canvas on pipe insulation shall be 8-ounce canvas drawn snugly in place over rosin-sized paper and shall have all laps cemented with lagging cement.

7.3 Flanges, valves, fittings, and bends for pipe sizes 10" and under shall have a 1/4"-thick coat of finish cement. Over this, the canvas shall be applied, cut, and cemented in place with lagging cement so that there will be no wrinkles.

7.4 For pipe sizes 12" and larger, and for equipment, Type J Finish shall consist of Type D Finish plus cemented canvas as described herein.

7.5 Type JJ Finish shall be the same as Type J Finish plus a brush coat of lagging cement applied over the entire exterior surface of the canvas to size and shrink the canvas.

7.6 Where exposed fittings over 300°F are located in the line, finish the ends of insulation as directed in paragraph 1.5

of Section E.

8.0 TYPE K FINISH

8.1 Type K Finish shall consist of asbestos cloth. It may be used over the insulation on pipe, flanges, valves, fittings, and equipment indoors covered with Class 1 insulation where a highly fire-resistant covering is required that is nonweather-proof.

| Finish Code | Asbestos Cloth Temp. °F | Kind of Asbestos Cloth |
|---|---|---|
| K | 350 maximum | Commercial Grade |
| K | 350 to 850 | 95% Plain Asbestos |

8.2 Type K Finish shall be asbestos cloth (Code U) drawn snugly over the insulation and held in place by cementing all laps with lagging cement (Code Y).

8.3 Flanges, valves, fittings, and bends for pipe sizes 10" and under shall have a 1/4"-thick coat of finish cement (Code H). Over this, the asbestos cloth shall be applied, cut, and cemented in place with lagging cement so that there will be no wrinkles.

8.4 For pipe sizes 12" and larger and for equipment, this finish shall consist of Type D Finish plus the asbestos cloth cemented in place.

# APPENDIX A

## TABLES

TABLE I

STANDARD THERMAL INSULATION

DIMENSIONS OF PIPE COVERING (IN INCHES)

| Nominal Pipe Size | *Outside Pipe Diameter | CORK | | | | | | 85% MAGNESIA** | |
|---|---|---|---|---|---|---|---|---|---|
| | | Ice Water Thick | | Brine Thick | | Special Brine Thick | | Std. Thick | Double Std. Thick |
| | | OD Cover | Insul Wall | OD Cover | Insul Wall | OD Cover | Insul Wall | | |
| 1/4" | .540 | J3.25 | 1.35 | J4.25 | 1.85 | J6.31 | 2.88 | .88 | 1.91 |
| 1/2" | .840 | J3.25 | 1.20 | J4.25 | 1.70 | J6.31 | 2.73 | .88 | 1.91 |
| 3/4" | 1.050 | J3.75 | 1.35 | J4.69 | 1.81 | J6.31 | 2.63 | .88 | 1.91 |
| 1" | 1.315 | J4.25 | 1.47 | J5.31 | 2.00 | J7.25 | 2.97 | .88 | 1.91 |
| 1-1/4" | 1.660 | J4.69 | 1.48 | J6.31 | 2.32 | J7.87 | 3.10 | .88 | 1.91 |
| 1-1/2" | 1.900 | J4.69 | 1.42 | J6.75 | 2.50 | J7.87 | 2.99 | .88 | 1.91 |
| 2" | 2.375 | J5.31 | 1.47 | J7.25 | 2.44 | J8.87 | 3.25 | 1.03 | 2.16 |
| 2-1/2" | 2.875 | J5.62 | 1.37 | J7.87 | 2.50 | J8.87 | 3.00 | 1.03 | 2.16 |
| 3" | 3.500 | J6.75 | 1.56 | J8.87 | 2.68 | J9.62 | 3.06 | 1.03 | 2.16 |
| 3-1/2" | 4.000 | J7.25 | 1.62 | J9.62 | 2.81 | J11.12 | 3.56 | 1.03 | 2.16 |
| 4" | 4.500 | J7.87 | 1.68 | J9.62 | 2.56 | J11.12 | 3.31 | 1.125 | 2.25 |
| 5" | 5.563 | J8.87 | 1.65 | J11.12 | 2.78 | J13.12 | 3.78 | 1.125 | 2.25 |
| 6" | 6.625 | J10.25 | 1.81 | J12.18 | 2.78 | J14.62 | 4.00 | 1.125 | 2.25 |
| 8" | 8.625 | J12.18 | 1.78 | J14.62 | 3.00 | L16.62 | 4.00 | 1.25 | 2.50 |
| 10" | 10.750 | J14.62 | 1.93 | L16.75 | 3.00 | L18.75 | 4.00 | 1.25 | 2.50 |
| 12" | 12.750 | L15.75 | 1.50 | L18.75 | 3.00 | L20.75 | 4.00 | 1.5 | 3.00 |
| 14" OD | 14.00 | L17.00 | 1.50 | L20.00 | 3.00 | L22.00 | 4.00 | 1.5 | 3.00 |
| 16" OD | 16.00 | L19.00 | 1.50 | L22.00 | 3.00 | L24.00 | 4.00 | 1.5 | 3.00 |
| 18" OD | 18.00 | L21.00 | 1.50 | L24.00 | 3.00 | L26.00 | 4.00 | 1.5 | 3.00 |
| 20" OD | 20.00 | L23.00 | 1.50 | L26.00 | 3.00 | L28.00 | 4.00 | 1.5 | 3.00 |
| 24" OD | 24.00 | | | | | | | 1.5 | 3.00 |
| 30" OD | 30.00 | | | | | | | 1.5 | 3.00 |

J - Molded Cork Section
L - Beveled Cork Lagging
*Per ASA B36.10
**Use magnesia of sizes listed on Table II whenever feasible.

TABLE II

STANDARD THERMAL INSULATION

BASIC SIZES OF INSULATION FOR PIPING

| Pipe Size | | Nominal 1-1/2" Thick | | Nominal 2" Thick | | Nominal 2-1/2" Thick | |
|---|---|---|---|---|---|---|---|
| N | OD | Thk. | OD | Thk. | OD | Thk. | OD |
| 1/4 | .540 | 1.453 | 3.500 | 1.953 | 4.500 | | |
| 3/8 | .675 | 1.641 | 4.000 | 2.141 | 5.000 | | |
| 1/2 | .840 | 1.562 | 4.000 | 2.062 | 5.000 | | |
| 3/4 | 1.050 | 1.437 | 4.000 | 1.937 | 5.000 | | |
| 1 | 1.315 | 1.562 | 4.500 | 2.093 | 5.562 | | |
| 1-1/4 | 1.660 | 1.625 | 5.000 | 1.906 | 5.562 | | |
| 1-1/2 | 1.900 | 1.531 | 5.000 | 1.844 | 5.562 | | |
| 2 | 2.375 | 1.562 | 5.562 | 2.094 | 6.625 | | |
| 2-1/2 | 2.875 | 1.312 | 5.562 | 1.844 | 6.625 | | |
| 3 | 3.500 | 1.531 | 6.625 | 2.031 | 7.625 | | |
| 3-1/2 | 4.000 | 1.281 | 6.625 | 1.776 | 7.625 | | |
| 4 | 4.500 | 1.531 | 7.625 | 2.031 | 8.625 | | |
| 4-1/2 | 5.000 | 1.281 | 7.625 | 1.831 | 8.625 | | |
| 5 | 5.563 | 1.500 | 8.625 | 2.000 | 9.625 | | |
| 6 | 6.625 | 1.437 | 9.625 | 2.000 | 10.750 | | |
| 7 | 7.625 | 1.500 | 10.750 | 2.000 | 11.750 | 2.500 | 12.750 |
| 8 | 8.625 | 1.500 | 11.750 | 2.000 | 12.750 | 2.687 | 14.125 |
| 9 | 9.625 | 1.500 | 12.750 | 2.187 | 14.125 | 2.687 | 15.125 |
| 10 | 10.750 | 1.625 | 14.125 | 2.125 | 15.125 | 2.625 | 16.125 |
| 11 | | 1.625 | 15.125 | 2.125 | 16.125 | 2.625 | 17.125 |
| 12 | 12.750 | 1.625 | 16.125 | 2.125 | 17.125 | 2.625 | 18.125 |
| 14" to 30" OD Pipe | | 1.500 | | 2.000 | | 2.500 | |

TABLE II

STANDARD THERMAL INSULATION

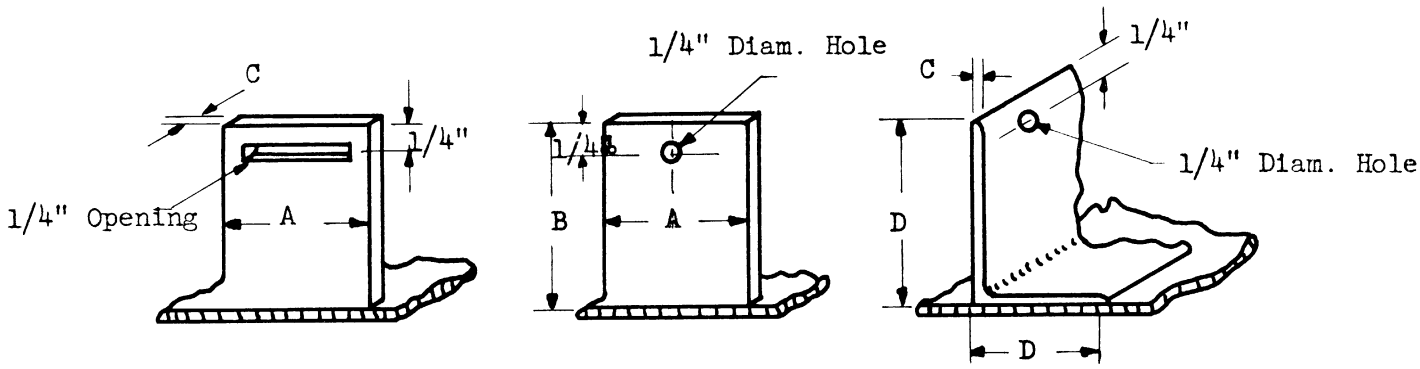
BASIC SIZES OF INSULATION FOR TUBING

| Tube Size | | Nominal 1" Thick | | Nominal 1-1/2" Thick | | Nominal 2" Thick | |
|---|---|---|---|---|---|---|---|
| N | OD | Thk. | OD | Thk. | OD | Thk. | OD |
| 3/8 | .375 | .969 | 2.375 | 1.531 | 3.500 | | |
| 1/2 | .500 | 1.141 | 2.875 | 1.453 | 3.500 | | |
| 5/8 | .625 | 1.076 | 2.875 | 1.641 | 4.000 | | |
| 3/4 | .750 | 1.062 | 2.875 | 1.564 | 4.000 | | |
| 7/8 | .875 | .969 | 2.875 | 1.531 | 4.000 | | |
| 1 | 1.000 | .906 | 2.875 | 1.476 | 4.000 | | |
| 1-1/8 | 1.125 | 1.157 | 3.500 | 1.657 | 4.500 | | |
| 1-1/4 | 1.250 | 1.094 | 3.500 | 1.594 | 4.500 | | |
| 1-3/8 | 1.375 | 1.375 | 3.500 | 1.531 | 4.500 | | |
| 1-1/2 | 1.500 | .969 | 3.500 | 1.469 | 4.500 | | |
| 1-5/8 | 1.625 | .906 | 3.500 | 1.657 | 5.000 | | |
| 2 | 2.000 | .969 | 4.000 | 1.469 | 5.000 | | |
| 2-1/8 | 2.125 | 1.157 | 4.500 | 1.687 | 5.562 | | |
| 2-1/2 | 2.500 | .969 | 4.500 | 1.500 | 5.562 | | |
| 2-5/8 | 2.625 | .906 | 4.500 | 1.437 | 5.562 | | |
| 3 | 3.000 | .969 | 5.000 | 1.786 | 6.625 | | |
| 3-1/8 | 3.125 | 1.187 | 5.562 | 1.719 | 6.625 | | |
| 4 | 4.000 | 1.276 | 6.625 | 1.776 | 7.625 | | |
| 4-1/8 | 4.125 | 1.219 | 6.625 | 1.719 | 7.625 | | |
| 5 | 5.000 | 1.276 | 7.625 | 1.776 | 8.625 | 2.276 | 9.625 |
| 5-1/8 | 5.125 | 1.219 | 7.625 | 1.719 | 8.625 | 2.219 | 9.625 |
| 6 | 6.000 | 1.276 | 8.625 | 1.776 | 9.625 | 2.344 | 10.750 |
| 6-1/8 | 6.125 | 1.219 | 8.625 | 1.719 | 9.625 | 2.281 | 10.750 |

TABLE III

STANDARD THERMAL INSULATION

CLIPS, STUDS, AND ANGLE-IRON BANDS FOR EQUIPMENT




BAND CLIP WIRE CLIP ANGLE-IRON BAND

| Dimensions | | | | |
|---|---|---|---|---|
| Thick. of Insulation | Wire Clips A x B x C | Band Clips A x B x C | Angle-Iron Bands D x D x C | Size of Wire |
| 1" to 1½" | 1" x 1" x 1/8" | 1" x 1" x | 1" x 1" x 1/8" | 10 Gage |
| 2" | 1½"x 1½"x 1/8" | 1½"x 1½"x1/8" | 1½"x 1½" x 1/8" | " |
| 2½" to 3" | 1½"x 2"x 3/16" | 1½"x 2"x3/16" | 2" x 2"x 3/16" | " |
| 4" to 6" | 1½"x 3"x 1/4" | 1½"x 3"x 1/4" | 3" x 3" x 1/4" | Bands |
| 7"and over | 2"x 4"x 3/8" | 2"x 4" x 3/8" | 4" x 4" x 3/8" | Bands |

TABLE IV

WIRE AND BANDS

| | Item | Mat'l | Size | Use |
|---|---|---|---|---|
| FOR PIPE COVERING | Wire or Bands | Copper | 0.081" diam.<br>1/2" x 0.020" | To hold roofing felt in place on pipe covering in all pipe sizes Bands are preferred where OD over roofing felt is greater than 14". |
| | Wire | Galv. Iron | 0.062" diam. (16 gage) | To hold insulation in place on pipe sizes 4" and under for Classes 1, 2, 3, and 4. |
| | Wire or Bands | Galv. Iron | 0.083" (14 gage)<br>1/2" x 0.020" | To hold insulation in place on pipe sizes over 4" for Classes, 1, 2, 3, and 4, as well as on all pipe sizes for Classes 5 and 7. Bands are preferred where OD of covering is greater than 14". |
| FOR EQUIPMENT | Bands (only) | Galv. Iron | 1/2" x 0.020" | To hold insulation in place on cylindrical equipment where OD of insulation is not more than 30" or other shaped equipment of equivalent perimeter. |
| | Bands (only) | Galv. Iron | 3/4" x 0.035" | To hold insulation in place on equipment larger than the above but not over 8-ft diameter or equivalent. |
| | Bands (only) | Galv. Iron | 1-1/4"x 0.035" | To hold insulation in place on equipment over 8-ft diameter. |

Where corrosive conditions exist, the size and material for bands and wires shall be stated on the drawings.

All wire and band material for noncorrosive application shall conform to the following:

Copper wire and bands shall meet ASTM Specification B-99, Types A, C, or D - Annealed.

Galvanized-iron wire shall meet ASTM Specification A-112.

Galvanized-iron bands shall be double-galvanized annealed steel strip.

Except as noted in the table, where wires are called for in this specification for holding covering or roofing felt in place on piping, it

will be permissible to use bands. When bands are substituted, the spacing shall be not less than 3 bands per section for pipe covering nor 4 bands per section for the asbestos roofing jacket. The wire and band sizes used shall comply with the table.

## HEAT LOSS FROM BARE SURFACES

### For Various Temperature Differences

TABLE V — Losses given in Btu per hour, per linear foot of bare pipe.

(*For finding losses at temperatures between those shown, the Btu increments per degree are used as in the example below.)

| Nominal pipe size, inches | Sq ft of pipe surface, per lin.ft | 50° | Per degree increment | TEMPERATURE DIFFERENCE, DEGREES F 100° | Per degree increment | 150° | Per degree increment | 200° | Per degree increment | 250° | Per degree increment | 300° | Per degree increment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | 0.220 | 21.5 | .52 | 47.3 | .64 | 79.2 | .76 | 117.3 | .90 | 162.3 | 1.06 | 215.2 | 1.28 |
| 3/4 | 0.275 | 26.8 | .65 | 59.2 | .80 | 99.0 | .95 | 146.6 | 1.13 | 202.9 | 1.32 | 269.0 | 1.60 |
| 1 | 0.344 | 33.5 | .81 | 74.0 | 1.00 | 123.8 | 1.19 | 183.4 | 1.41 | 253.8 | 1.65 | 336.4 | 2.01 |
| 1-1/4 | 0.435 | 42.4 | 1.02 | 93.6 | 1.26 | 156.6 | 1.51 | 231.9 | 1.78 | 320.9 | 2.09 | 425.4 | 2.54 |
| 1-1/2 | 0.498 | 48.6 | 1.17 | 107.2 | 1.44 | 179.3 | 1.72 | 265.4 | 2.04 | 367.4 | 2.39 | 487.0 | 2.90 |
| 2 | 0.622 | 60.7 | 1.46 | 133.9 | 1.80 | 223.9 | 2.15 | 331.5 | *2.55 | 458.9 | 2.99 | 608.3 | 3.63 |
| 2-1/2 | 0.753 | 73.4 | 1.77 | 162.1 | 2.18 | 271.1 | 2.61 | 401.4 | 3.08 | 555.6 | 3.62 | 736.4 | 4.39 |
| 3 | 0.917 | 89.4 | 2.16 | 197.3 | 2.66 | 330.1 | 3.17 | 488.8 | 3.76 | 676.6 | 4.40 | 896.8 | 5.34 |
| 3-1/2 | 1.047 | 102.1 | 2.46 | 225.3 | 3.03 | 376.9 | 3.62 | 558.1 | 4.29 | 772.5 | 5.03 | 1024.0 | 6.10 |
| 4 | 1.178 | 114.9 | 2.77 | 253.5 | 3.41 | 424.1 | 4.08 | 627.9 | 4.82 | 869.1 | 5.66 | 1152.0 | 6.88 |
| 4-1/2 | 1.309 | 127.6 | 3.08 | 281.7 | 3.79 | 471.2 | 4.53 | 697.7 | 5.35 | 965.1 | 6.30 | 1280.0 | 7.64 |
| 5 | 1.456 | 142.0 | 3.43 | 313.3 | 4.22 | 524.2 | 5.04 | 776.1 | 5.96 | 1074.0 | 7.00 | 1424.0 | 8.48 |
| 6 | 1.734 | 169.1 | 4.08 | 373.2 | 5.02 | 624.2 | 6.00 | 924.2 | 7.10 | 1279.0 | 8.34 | 1696.0 | 10.10 |
| 7 | 1.996 | 194.6 | 4.70 | 429.5 | 5.78 | 718.6 | 6.91 | 1064.0 | 8.18 | 1473.0 | 9.58 | 1952.0 | 11.64 |
| 8 | 2.257 | 220.1 | 5.31 | 485.7 | 6.54 | 812.5 | 7.81 | 1203.0 | 9.24 | 1665.0 | 10.84 | 2207.0 | 13.16 |
| 9 | 2.519 | 245.6 | 5.93 | 542.1 | 7.29 | 906.8 | 8.72 | 1343.0 | 10.32 | 1859.0 | 12.10 | 2464.0 | 14.68 |
| 10 | 2.817 | 274.7 | 6.63 | 606.2 | 8.16 | 1014.0 | 9.76 | 1502.0 | 11.52 | 2078.0 | 13.54 | 2755.0 | 16.42 |
| 11 | 3.073 | 299.6 | 7.23 | 661.3 | 8.89 | 1106.0 | 10.64 | 1638.0 | 12.58 | 2267.0 | 14.76 | 3005.0 | 17.92 |
| 12 | 3.338 | 325.5 | 7.86 | 718.3 | 9.67 | 1202.0 | 11.54 | 1779.0 | 13.68 | 2463.0 | 16.04 | 3265.0 | 19.46 |
| 14 OD | 3.663 | 357.1 | 8.62 | 788.3 | 10.61 | 1319.0 | 12.66 | 1952.0 | 15.02 | 2703.0 | 17.58 | 3582.0 | 21.36 |
| 16 OD | 4.188 | 408.3 | 9.86 | 901.3 | 12.13 | 1508.0 | 14.48 | 2232.0 | 17.16 | 3090.0 | 20.12 | 4096.0 | 24.42 |
| 18 OD | 4.716 | 459.8 | 11.10 | 1015.0 | 13.66 | 1698.0 | 16.32 | 2514.0 | 19.32 | 3480.0 | 22.64 | 4612.0 | 27.50 |
| 20 OD | 5.235 | 510.4 | 12.33 | 1127.0 | 15.16 | 1885.0 | 18.10 | 2790.0 | 21.44 | 3862.0 | 25.16 | 5120.0 | 30.52 |
| 24 OD | 6.286 | 612.9 | 14.80 | 1353.0 | 18.20 | 2263.0 | 21.74 | 3350.0 | 25.76 | 4638.0 | 30.20 | 6148.0 | 36.64 |
| 30 OD | 7.854 | 765.8 | 18.48 | 1690.0 | 22.74 | 2827.0 | 27.18 | 4186.0 | 32.18 | 5795.0 | 37.72 | 7681.0 | 45.80 |

HEAT LOSS FROM BARE SURFACES
(Cont't)

| Nominal pipe size, inches | Sq ft of pipe surface, per lin. ft | TEMPERATURE DIFFERENCE, DEGREES F 350° | Per degree increment | 400° | Per degree increment | 450° | Per degree increment | 500° | Per degree increment | 550° | Per degree increment | 600° | Per degree increment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | 0.220 | 279.3 | 1.52 | 355.1 | 1.73 | 441.7 | 1.99 | 541.2 | 2.17 | 649.8 | 2.45 | 772.2 | 2.63 |
| 3/4 | 0.275 | 349.1 | 1.90 | 443.9 | 2.16 | 552.1 | 2.49 | 676.5 | 2.71 | 812.2 | 3.06 | 965.3 | 3.29 |
| 1 | 0.344 | 436.7 | 2.37 | 555.2 | 2.71 | 690.6 | 2.71 | 846.2 | 3.40 | 1016.0 | 3.82 | 1207.0 | 4.14 |
| 1-1/4 | 0.435 | 552.2 | 3.00 | 702.1 | 3.42 | 873.3 | 3.93 | 1070.0 | 4.30 | 1285.0 | 4.84 | 1527.0 | 5.20 |
| 1-1/2 | 0.498 | 632.2 | 3.43 | 803.8 | 3.92 | 999.7 | 4.51 | 1225.0 | 4.92 | 1471.0 | 5.54 | 1748.0 | 5.96 |
| 2 | 0.622 | 789.6 | 4.29 | 1004.0 | 4.90 | 1249.0 | 5.62 | 1530.0 | 6.14 | 1837.0 | 6.92 | 2183.0 | 7.44 |
| 2-1/2 | 0.753 | 955.9 | 5.18 | 1215.0 | 5.94 | 1512.0 | 6.80 | 1852.0 | 7.44 | 2224.0 | 8.38 | 2643.0 | 9.00 |
| 3 | 0.917 | 1164.0 | 6.32 | 1480.0 | 7.22 | 1841.0 | 8.30 | 2256.0 | 9.04 | 2708.0 | 10.22 | 3219.0 | 10.96 |
| 3-1/2 | 1.047 | 1329.0 | 7.22 | 1690.0 | 8.24 | 2102.0 | 9.48 | 2576.0 | 10.32 | 3092.0 | 11.66 | 3675.0 | 12.52 |
| 4 | 1.178 | 1496.0 | 8.10 | 1901.0 | 9.28 | 2365.0 | 10.66 | 2898.0 | 11.62 | 3479.0 | 13.12 | 4135.0 | 14.08 |
| 4-1/2 | 1.309 | 1662.0 | 9.02 | 2113.0 | 10.30 | 2628.0 | 11.84 | 3220.0 | 12.92 | 3866.0 | 14.58 | 4595.0 | 15.64 |
| 5 | 1.456 | 1848.0 | 10.04 | 2350.0 | 11.46 | 2923.0 | 13.18 | 3582.0 | 14.36 | 4300.0 | 16.22 | 5111.0 | 17.40 |
| 6 | 1.734 | 2201.0 | 11.96 | 2799.0 | 13.64 | 3481.0 | 15.70 | 4266.0 | 17.10 | 5121.0 | 19.30 | 6086.0 | 20.74 |
| 7 | 1.996 | 2534.0 | 13.76 | 3222.0 | 15.70 | 4007.0 | 18.06 | 4910.0 | 19.68 | 5894.0 | 22.24 | 7006.0 | 23.88 |
| 8 | 2.257 | 2865.0 | 15.56 | 3643.0 | 17.76 | 4531.0 | 20.42 | 5552.0 | 22.28 | 6666.0 | 25.12 | 7922.0 | 27.00 |
| 9 | 2.519 | 3198.0 | 17.36 | 4066.0 | 19.82 | 5057.0 | 22.80 | 6197.0 | 24.86 | 7440.0 | 28.04 | 8842.0 | 30.20 |
| 10 | 2.817 | 3576.0 | 19.42 | 4547.0 | 22.16 | 5655.0 | 25.50 | 6930.0 | 27.80 | 8320.0 | 31.36 | 9888.0 | 33.60 |
| 11 | 3.073 | 3901.0 | 21.18 | 4960.0 | 24.18 | 6169.0 | 27.82 | 7560.0 | 30.32 | 9076.0 | 34.36 | 10790.0 | 36.60 |
| 12 | 3.338 | 4238.0 | 23.00 | 5388.0 | 26.26 | 6701.0 | 30.22 | 8212.0 | 32.94 | 9859.0 | 37.20 | 11720.0 | 39.80 |
| 14 OD | 3.663 | 4650.0 | 25.24 | 5912.0 | 28.84 | 7354.0 | 33.14 | 9011.0 | 36.20 | 10820.0 | 40.80 | 12860.0 | 43.80 |
| 16 OD | 4.188 | 5317.0 | 28.84 | 6759.0 | 32.96 | 8407.0 | 37.90 | 10300.0 | 41.40 | 12370.0 | 46.60 | 14700.0 | 50.00 |
| 18 OD | 4.716 | 5987.0 | 32.50 | 7612.0 | 37.10 | 9467.0 | 40.70 | 11600.0 | 46.60 | 13930.0 | 52.40 | 16550.0 | 56.40 |
| 20 OD | 5.235 | 6646.0 | 36.06 | 8449.0 | 41.20 | 10510.0 | 47.40 | 12860.0 | 51.60 | 15460.0 | 58.40 | 18380.0 | 62.60 |
| 24 OD | 6.286 | 7980.0 | 43.40 | 10150.0 | 49.40 | 12620.0 | 56.80 | 15460.0 | 62.20 | 18570.0 | 69.80 | 22060.0 | 75.20 |
| 30 OD | 7.854 | 9971.0 | 54.18 | 12680.0 | 61.80 | 15770.0 | 71.00 | 19320.0 | 77.60 | 23200.0 | 87.40 | 27570.0 | 93.80 |

*Example: 2" pipe, 235° temperature difference; 235°-200° = 35°; 35 x 2.55 (Btu per degree) = 89.3 Btu
331.5 + 89.3 = 420.8 Btu loss at 235° temperature difference.

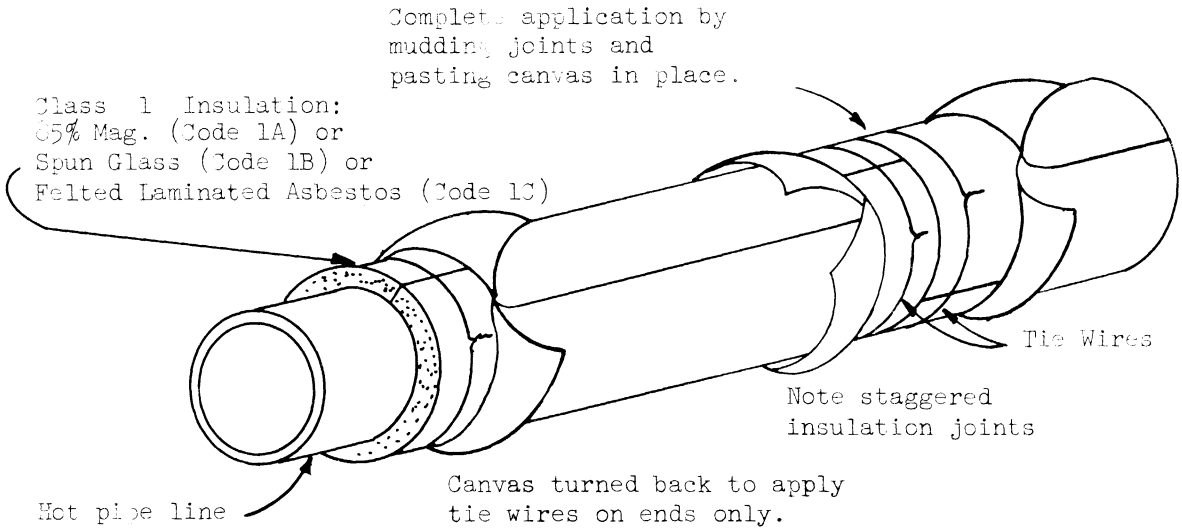
# APPENDIX B

## FIGURES

General

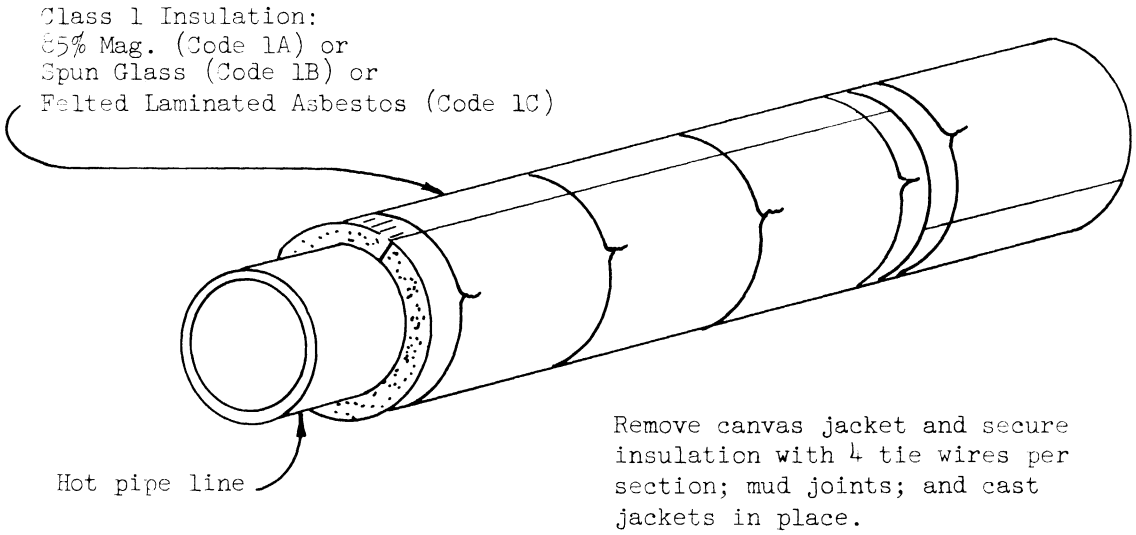
The illustrations included in this section are intended to picture the recommended methods of installing the various insulations and finishes. These figures shall be a part of the preceding insulation specification and all application shall conform with these appended figures unless specific exception is made by the Owner's Representative.

STANDARD THERMAL INSULATION



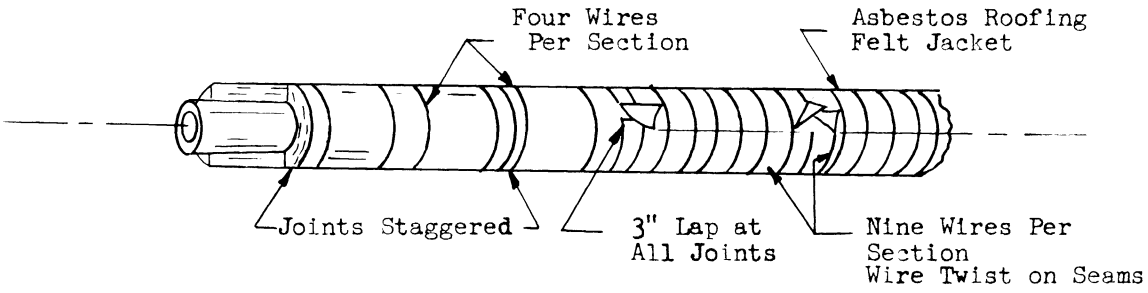

SECTIONAL INSULATION FOR LINES
4" O. D. AND SMALLER
PASTED CANVAS FINISH

**Figure 1**



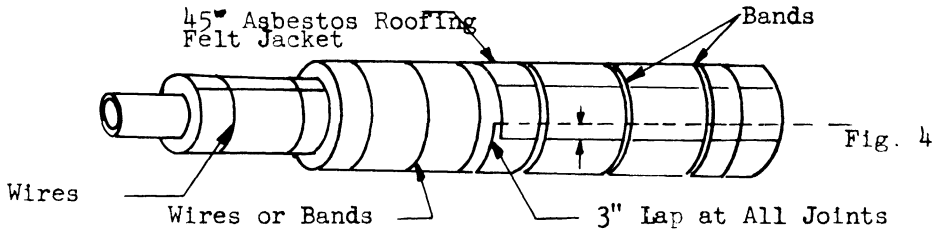

SECTIONAL INSULATION FOR LINES
LARGER THAN 4" O. D.
PASTED CANVAS FINISH

**Figure 2**



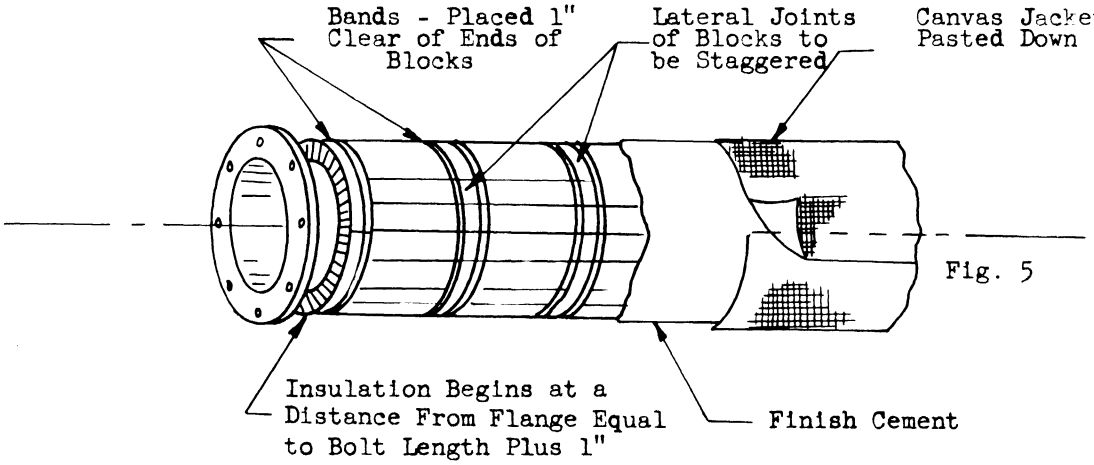

MOLDED SECTIONAL PIPE
COVERING (Class 1) WEATHERPROOF
(Type -F) FINISH
SINGLE LAYER

**Figure 3**




MOLDED SECTIONAL PIPE COVERING
(Class 1) WEATHERPROOF (Type-F) FINISH
DOUBLE LAYER

**Figure 4**




MOLDED SEGMENTAL COVERING ON PIPE 12" AND LARGER
(Class 1) PASTED (Type A)
CANVAS FINISH

**Figure 5**

STANDARD THERMAL INSULATION

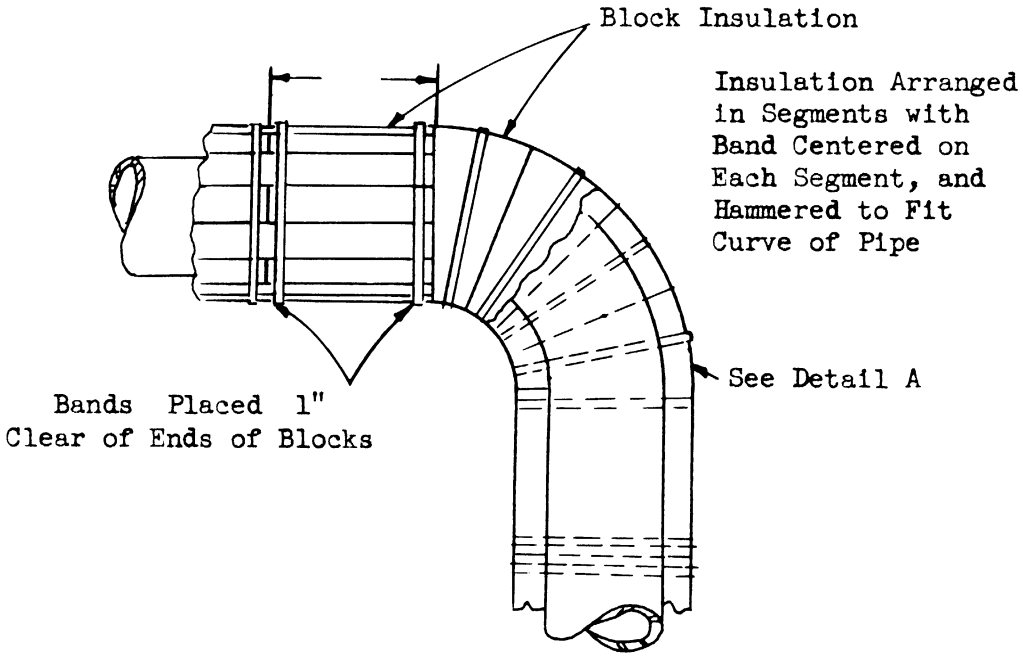
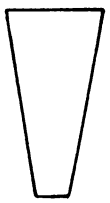



Figure 6
(FINISH NOT SHOWN)

DETAIL A

Wedge Segment (Before Bending), Used to Cover 1/2 Circumference of 90° Ell



Strike Block at Intervals to Permit Bending to Fit Pipe

BLOCK INSULATION (Class 1) ON

WELDING ELL 12" & LARGER

Figure 7

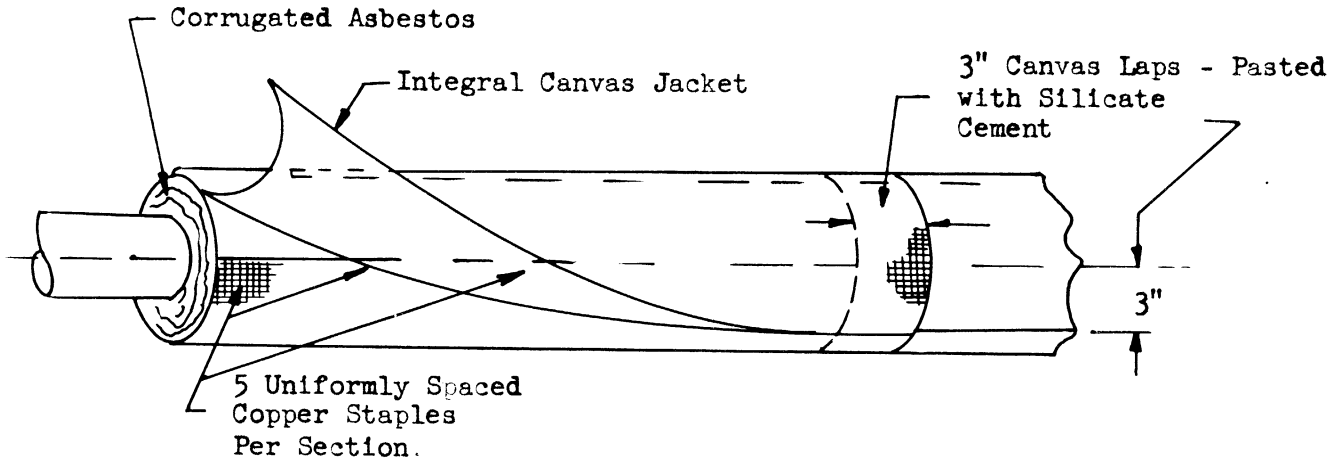



Figure 8

CORRUGATED ASBESTOS (Code 2A)
WITH PASTED INTEGRAL JACKET FINISH ( Type A )

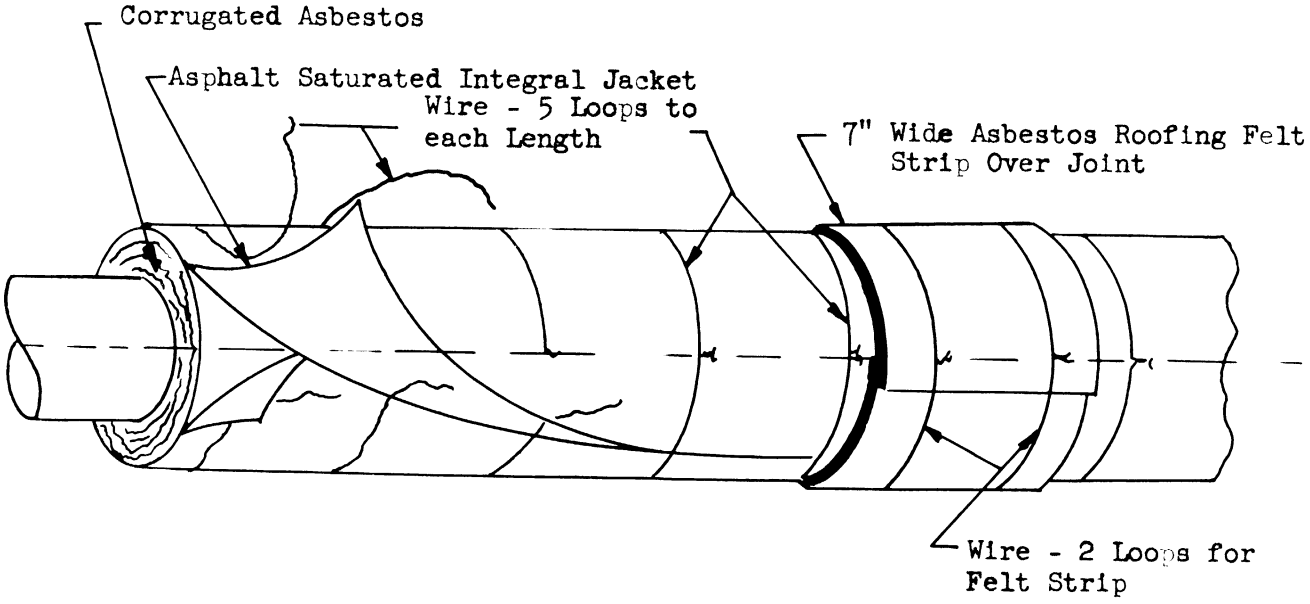
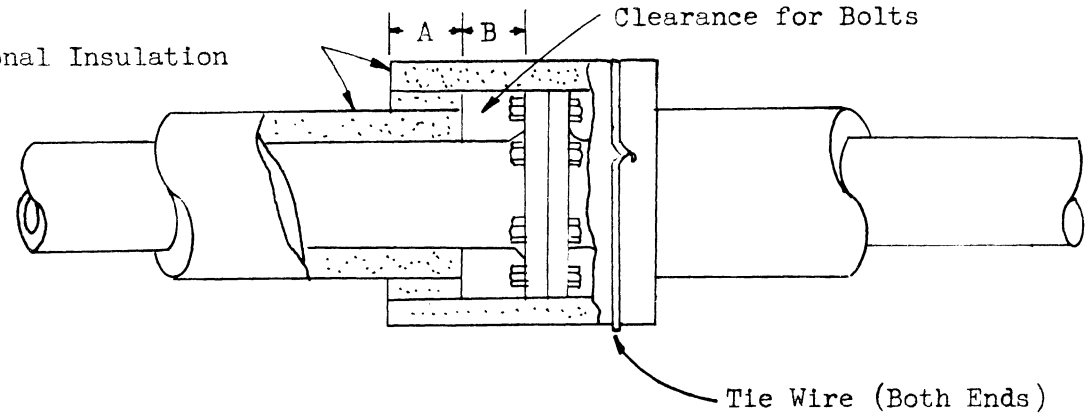



Figure 9

CORRUGATED ASBESTOS (Code 2A)
WITH WEATHERPROOF FINISH (Type F)



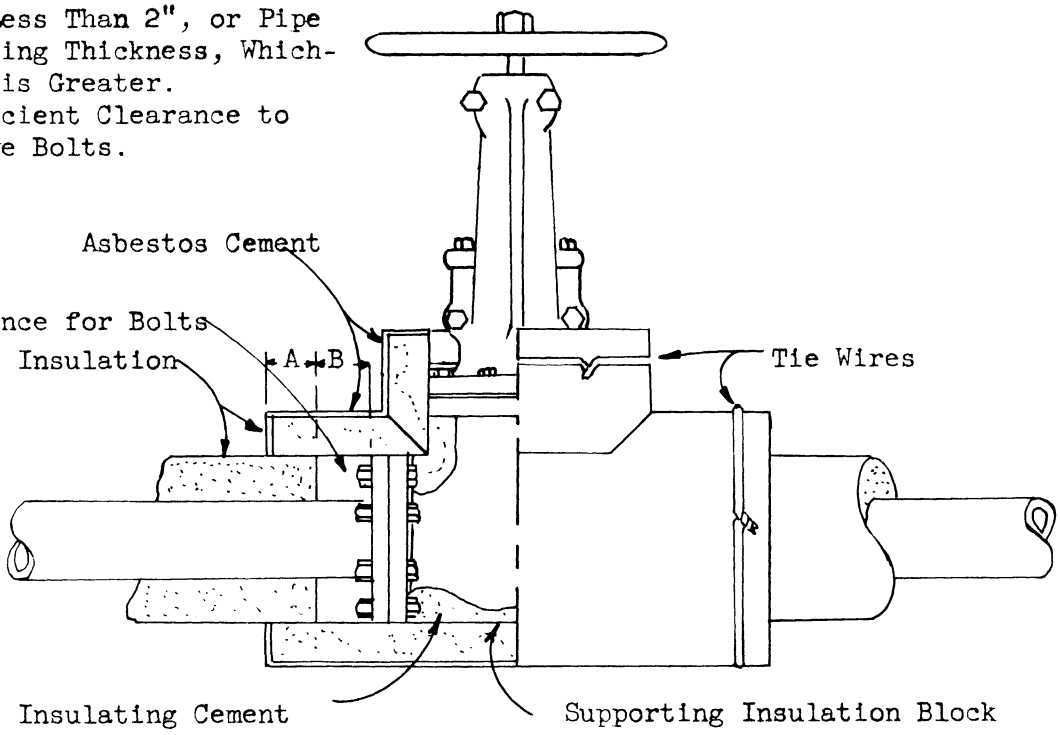

(FINISH NOT SHOWN)

FLANGE COVER
(Class 1) INSULATION

**Figure 10**

LEGEND

A = Not Less Than 2", or Pipe Covering Thickness, Whichever is Greater.
B = Sufficient Clearance to Remove Bolts.




(FINISH NOT SHOWN)

VALVE COVER
(Class 1) INSULATION

**Figure 11**

STANDARD THERMAL INSULATION

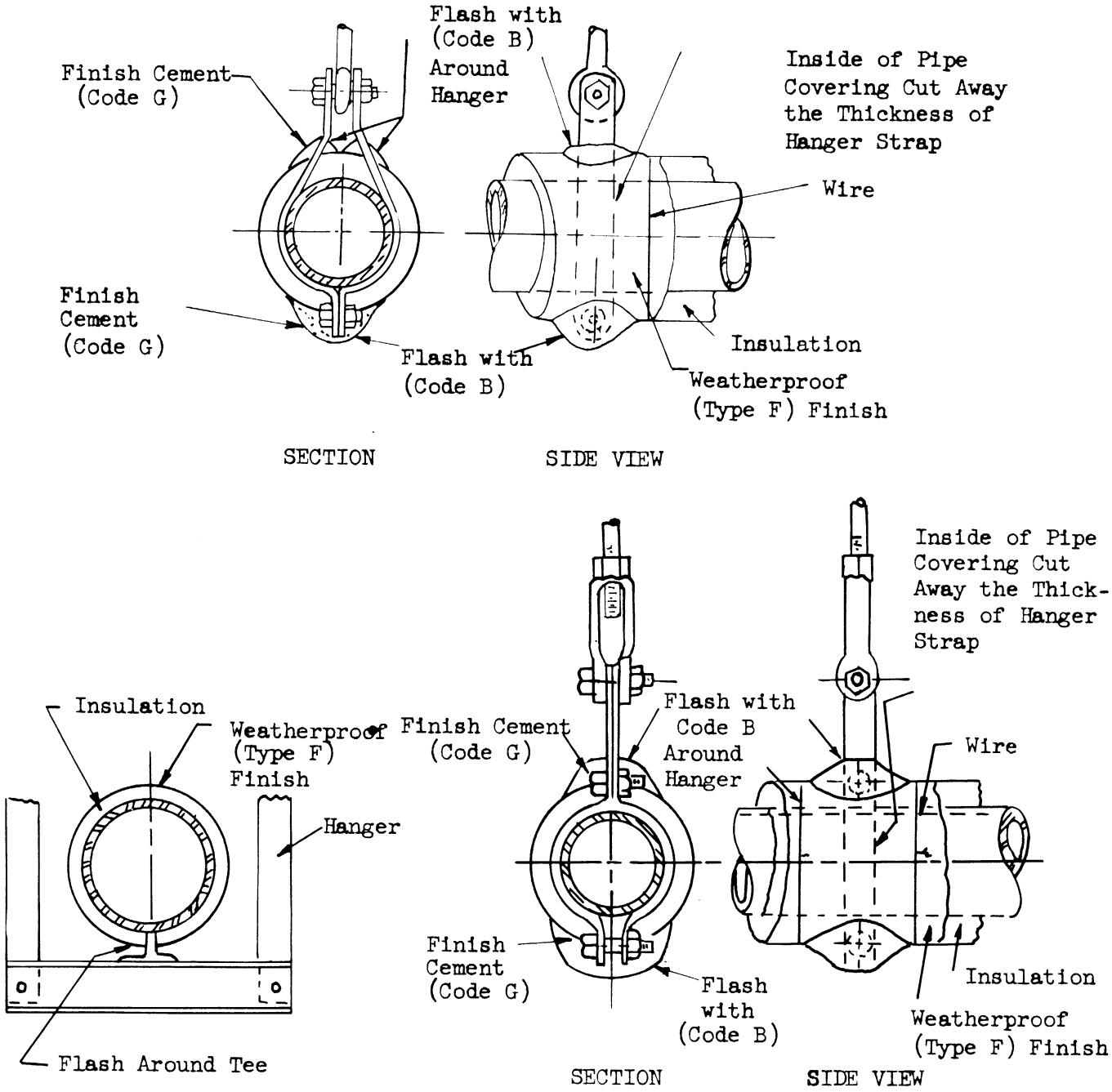
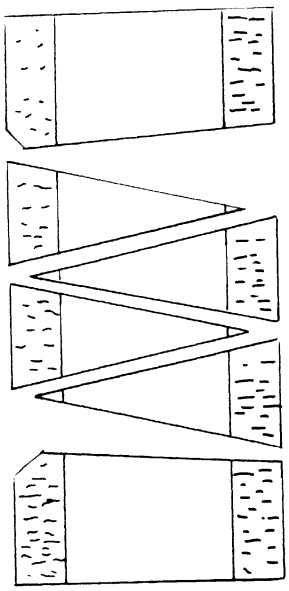



Figure 12

PIPE HANGERS INSULATION (Class 1)

The above sketches show application of weatherproof finish around pipe hangers. Where Non-Weatherproof finish (Type A, AA, J, JJ) is called for, the insulation shall be applied as shown above, using finish cement (Code G) to build up the insulation over the bottom of the hanger clamp and around the top of the hanger clamp. The materials of the particular type of finish called for shall then be applied over the insulation and finish cement.

STANDARD THERMAL INSULATION



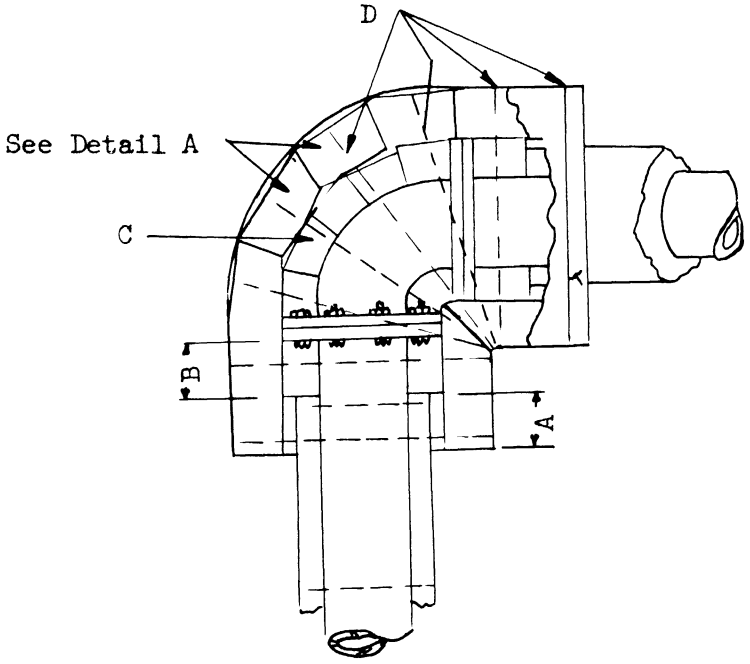
DETAIL A

Showing segments cut from sectional pipe covering (Covers for welding fittings made in similar manner.)

LEGEND:

A - Not less than 2"
B - Clearance to remove bolts
C - Block support for Cover
D - Wires or bands on not over 6" centers

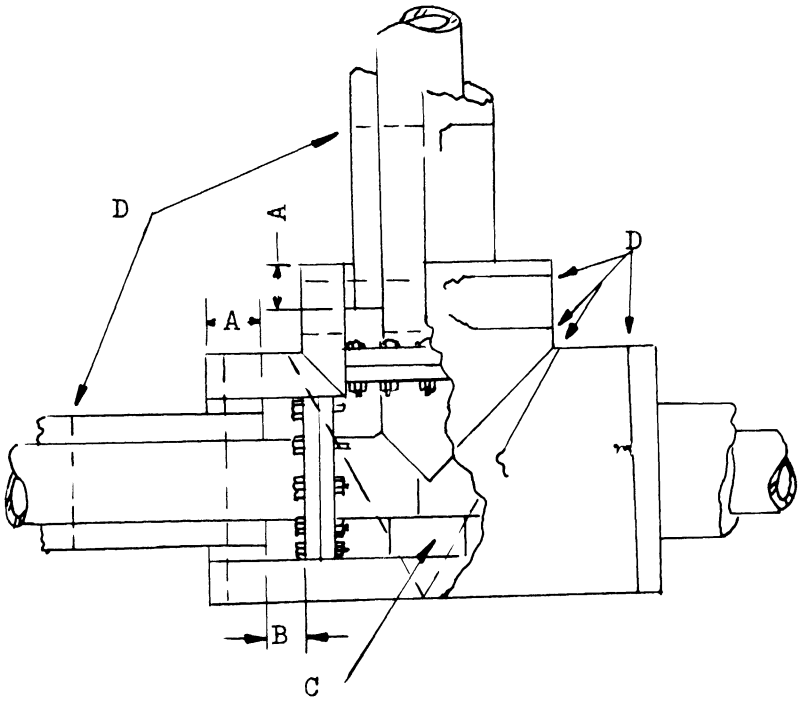
FLANGED TEE COVER
(Class 1) Insulation




(FINISH NOT SHOWN)

Figure 13

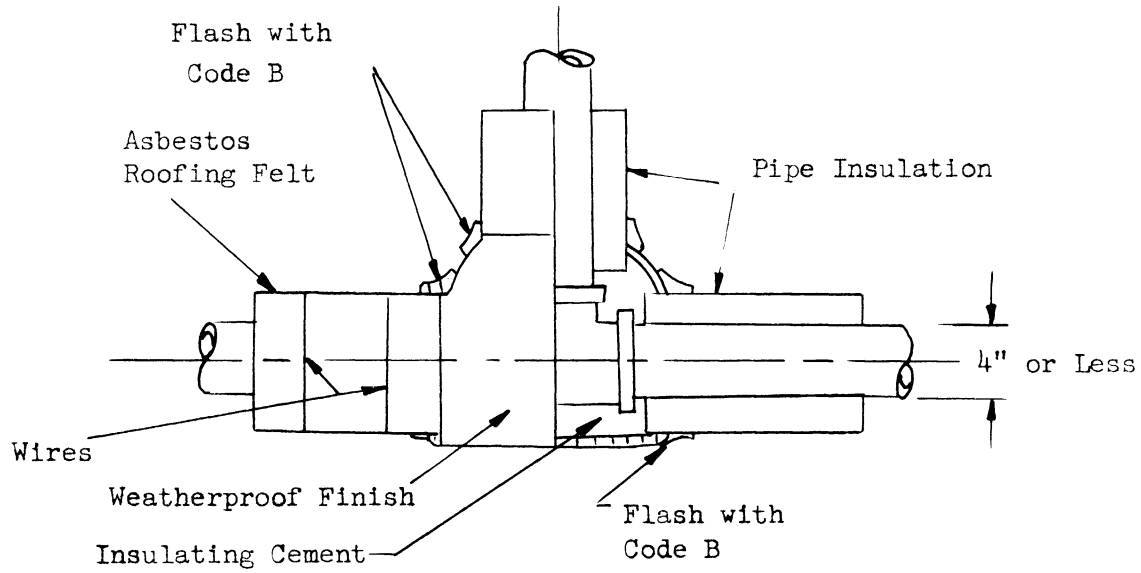
FLANGED ELL COVER
(Class 1) Insulation




(FINISH NOT SHOWN)

Figure 14

STANDARD THERMAL INSULATION



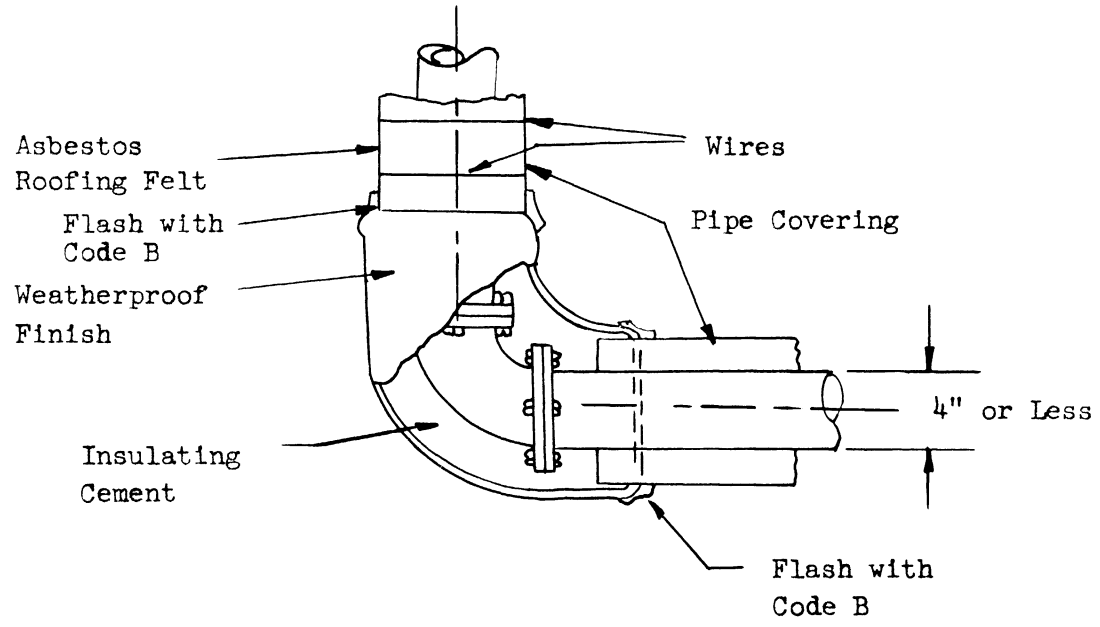
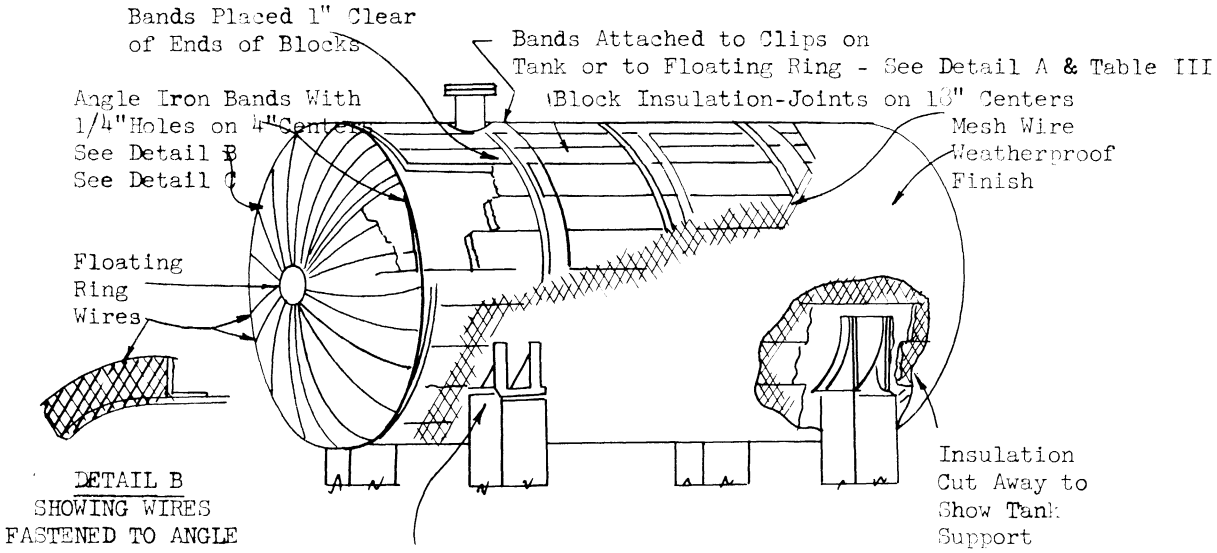



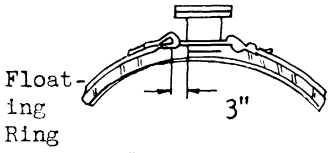

**Figure 15**

INSULATING CEMENT ON FITTINGS

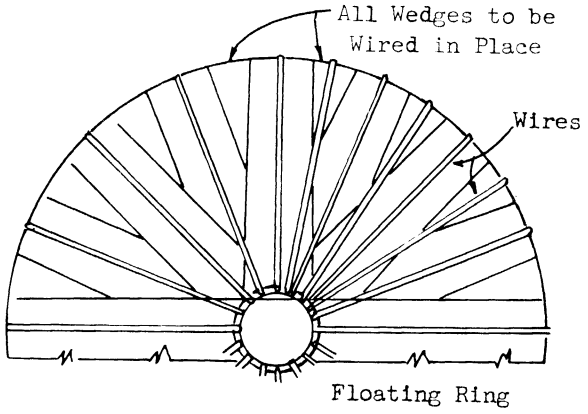
With Weatherproof (Type F) Finish




DETAIL B
SHOWING WIRES FASTENED TO ANGLE
For Details of Angle Iron Band, See Fig. 27 and Table III.




DETAIL A
Showing Band Attached to Floating Ring



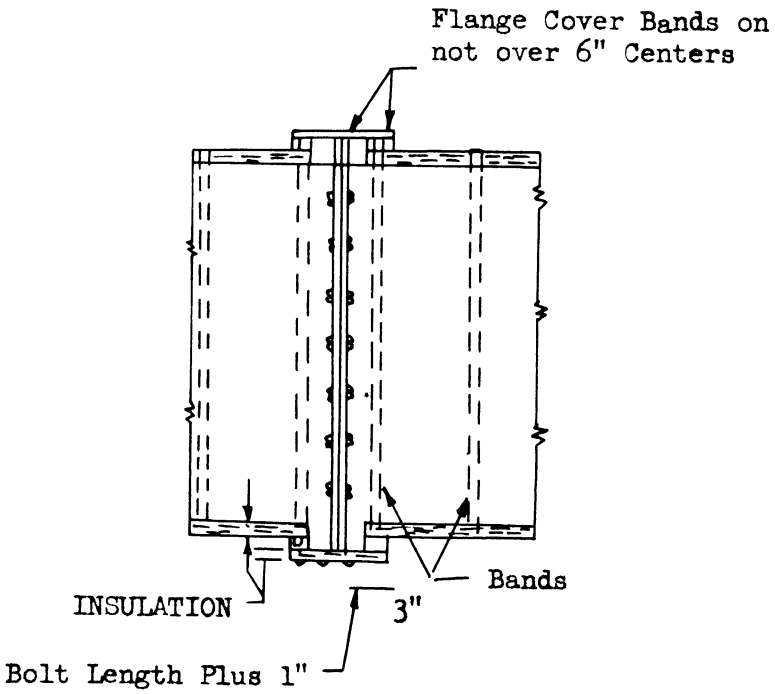

DETAIL C

Method of Wiring Insulation To Top and Bottom Heads

CURVED OR CYLINDRICAL EQUIPMENT

(Classes 1 and 2) Insulation With Weatherproof (Type E) Finish

**Figure 16**

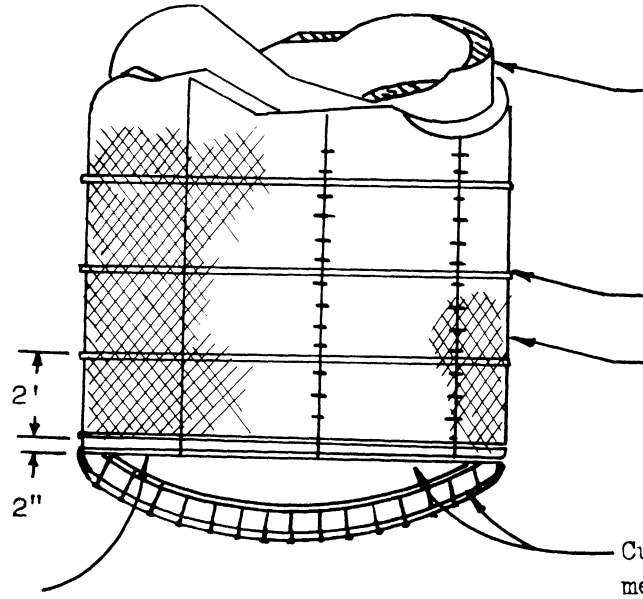



COVER FOR EQUIPMENT FLANGE

(Classes 1 and 2) Insulation

Figure 17

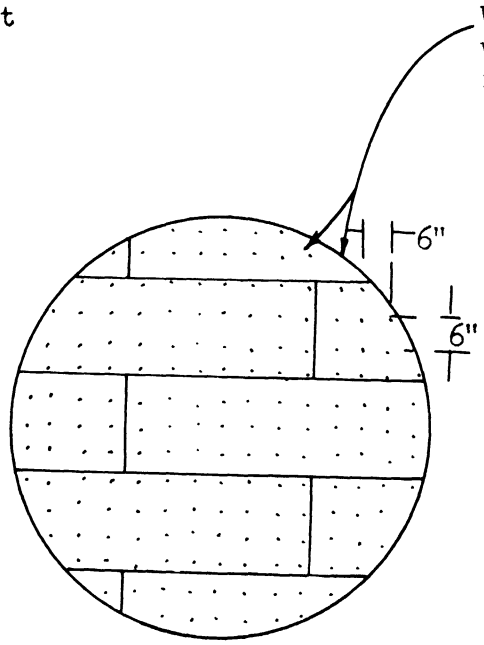
STANDARD THERMAL INSULATION




Angle iron band to support side insulation on vertical cylindrical equipment

Note:

All Insulation shall be banded and wired and the bands and wires laced to the wire backing of the blanket insulation so that the finished work will show no sagging, buckling, or separation from the surface being insulated.




Showing preferred method of insulating head. (Floating ring method may be used where welding is not permitted - See Fig. 14A)

Showing methods of securing blanket on cylindrical and odd shaped surfaces.

BLANKET INSULATION
(Class 4) ON EQUIPMENT

Figure 18

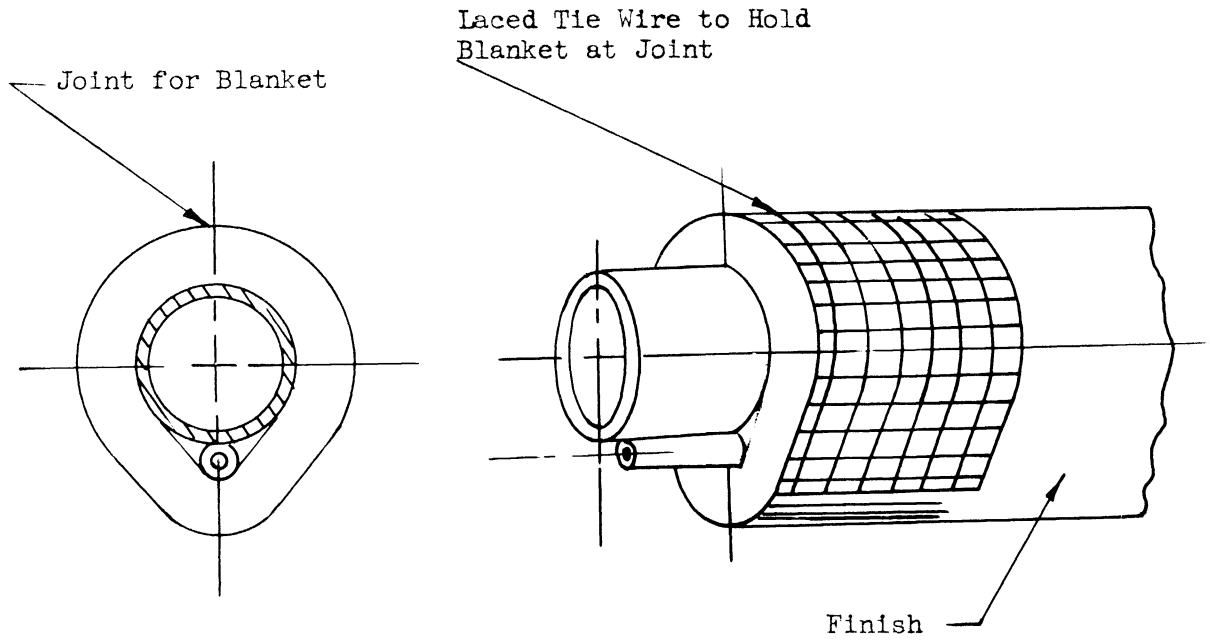
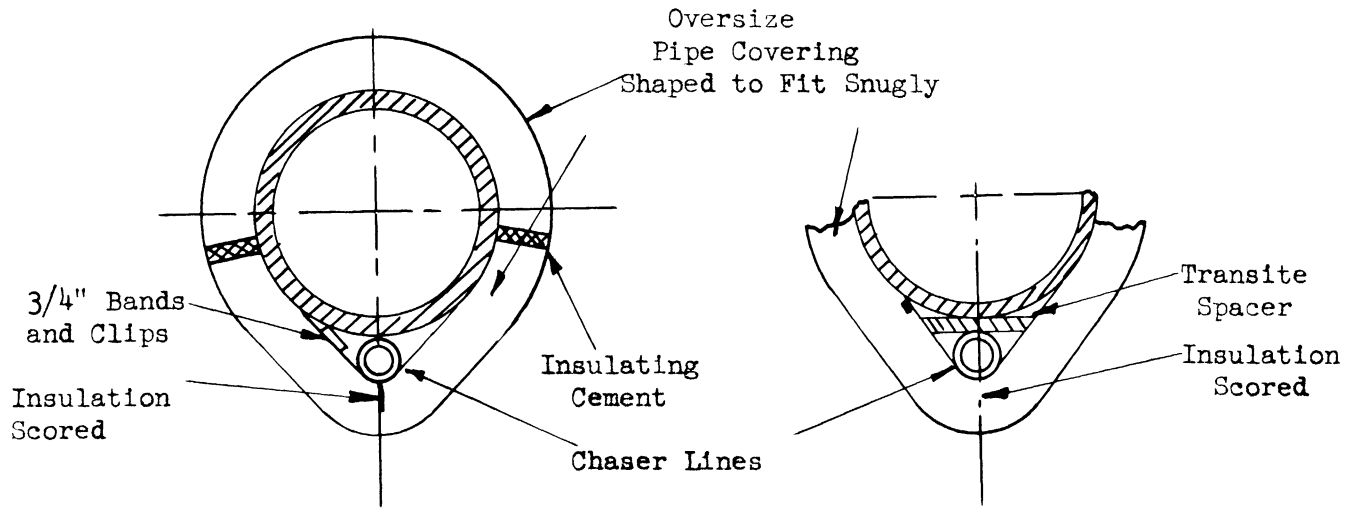


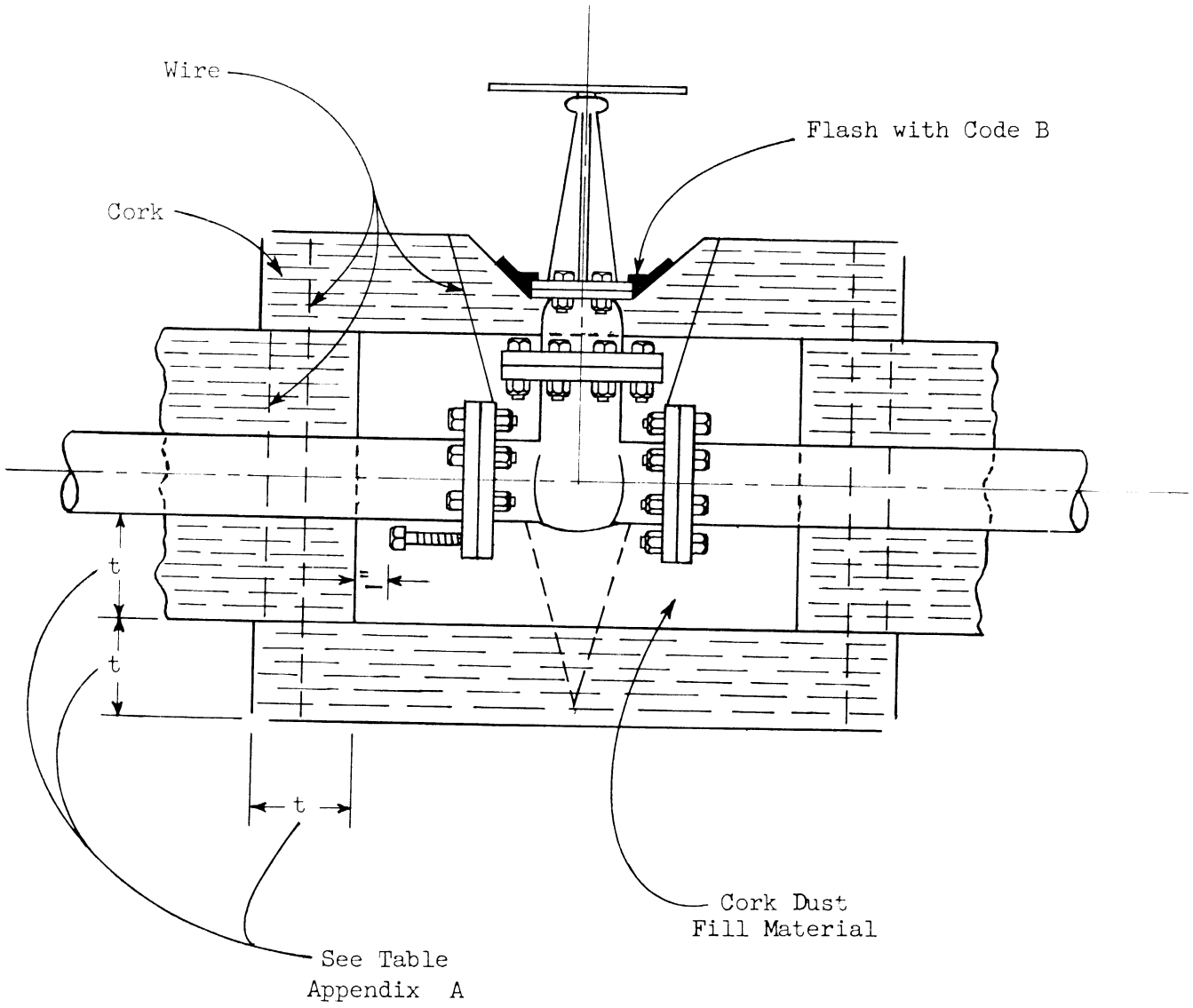

Figure 19

BLANKET INSULATION (Class 4)
ON PIPE




INSULATING CHASED LINES

Figure 20




BUILT-UP FLANGED VALVE COVER

LOW TEMPERATURE FORMED INSULATION
(Code 6A or 6B)

**Figure 21**

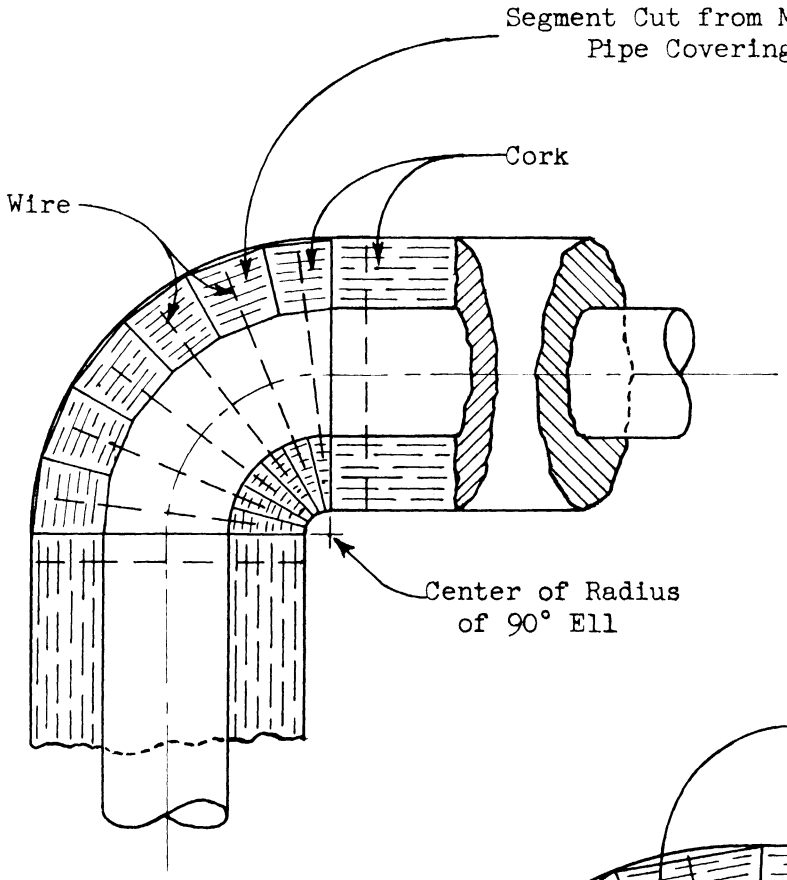



**Figure 22**

BUILT-UP
WELDING ELL COVER
Low Temperature
Formed Insulation
(Code 6A or 6B)

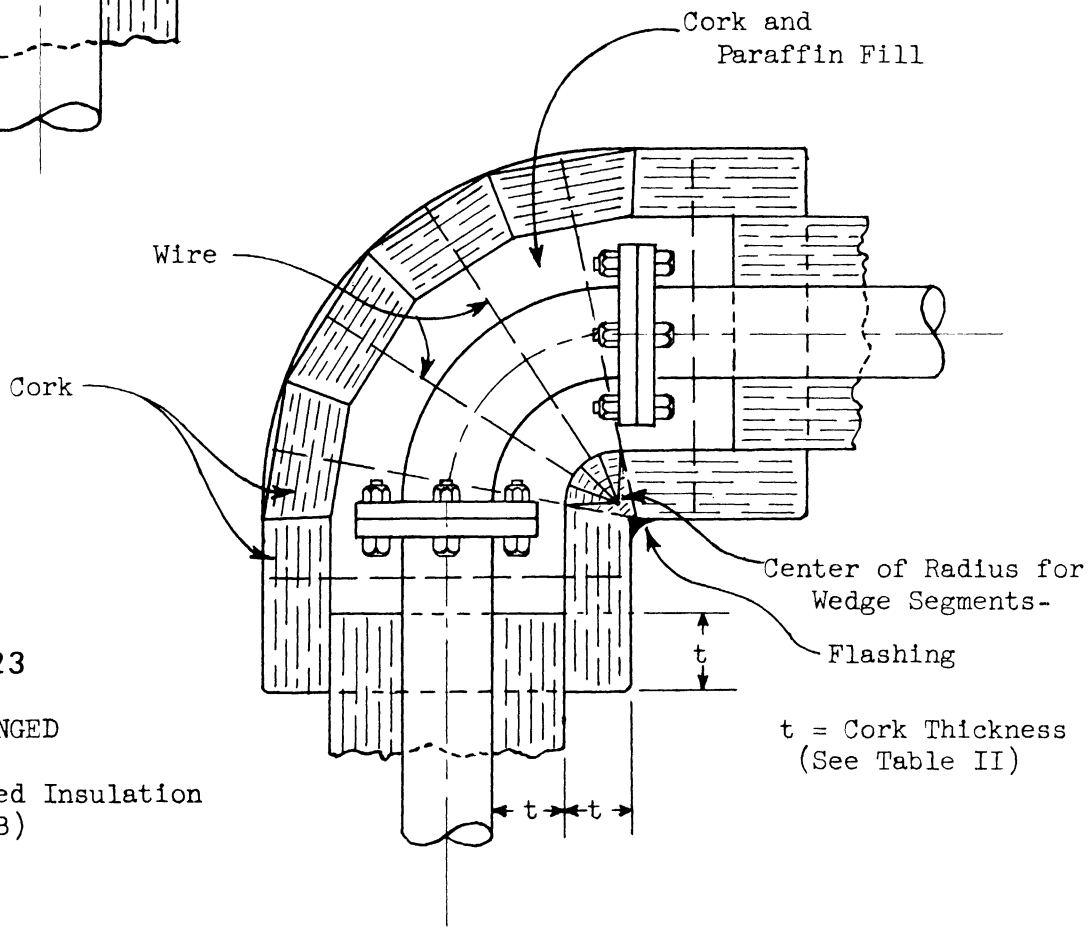


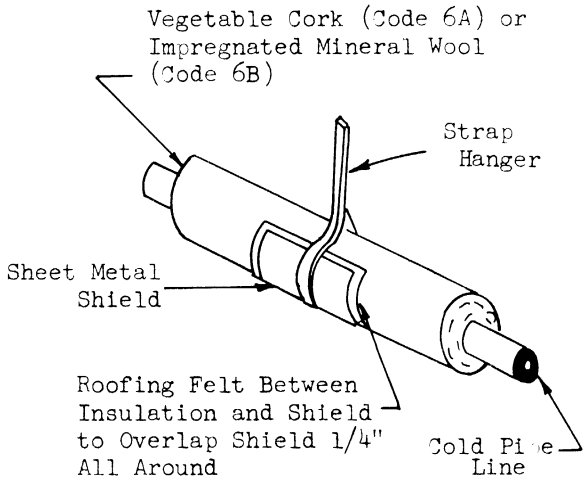

**Figure 23**

BUILT-UP FLANGED
ELL COVER
Low Temperature formed Insulation
(Code 6A, 6B)

t = Cork Thickness
(See Table II)

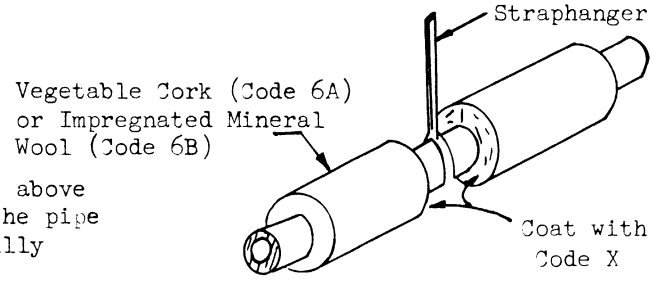
## STANDARD THERMAL INSULATION

Length = Outside Diameter of Insulation
Circumference = 2.5 Times O.D. of Insulation
Thickness = 12 Ga. when O.D. of Insulation is Less than 3", and 10 Ga. when O.D. of Insulation is 8" or More.




FOR USE WHEN THE FOLLOWING LOADS PER HANGER ARE NOT EXCEEDED:

| Pipe Size and Load in Pounds | | | | | |
|---|---|---|---|---|---|
| Insulation Thickness | 1 1/2" | 2 1/2" | 4" | 6" | 8" |
| Water | 500 | 600 | 900 | 1000 | 1500 |
| Brine | 600 | 800 | 1000 | 1100 | 1600 |
| Heavy Brine | 800 | 1000 | 1100 | 1200 | 1800 |

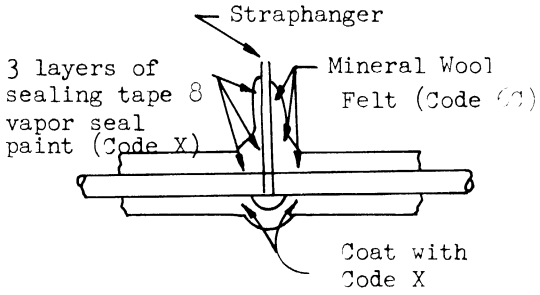



Where the load per hanger exceeds the above table, the hanger shall be attached to the pipe as shown in Figs. 26-B & 26-C and carefully insulated and sealed as follows:

(1) Insulation should be applied not closer than 2" to 3" from the hanger on either side.

(2) The exposed ends of the pipe insulation should be coated with vapor seal paint (Code X), and the pipe and hanger painted with weather resistant paint (Code W).

(3) Two or three (3 for heavy brine) built-up layers of mineral wool felt (Code 6C) should be applied with a double wrap of sealing tape per layer sealed to insulation and hanger as shown, and code X applied to each layer and all ends.

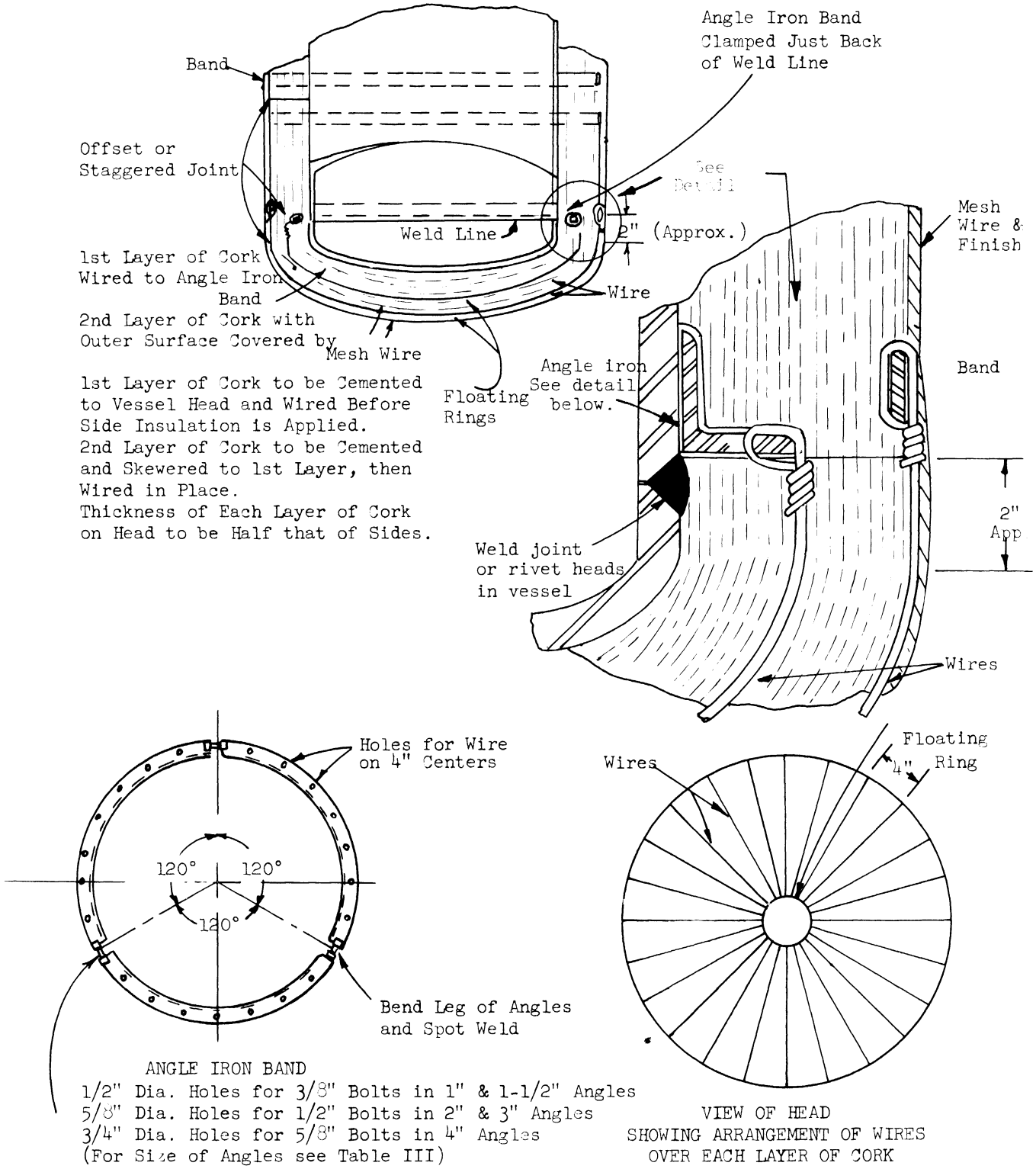



(4) A supplementary built-up layer of code 6C about 1 1/2" thick should be carried up the hanger at least 12".

(5) A double wrap of sealing tape should be sealed to the hanger at the upper end and to the membrane over the insulation at the lower end.

HANGER INSULATION ON COLD LINES

Figure 24



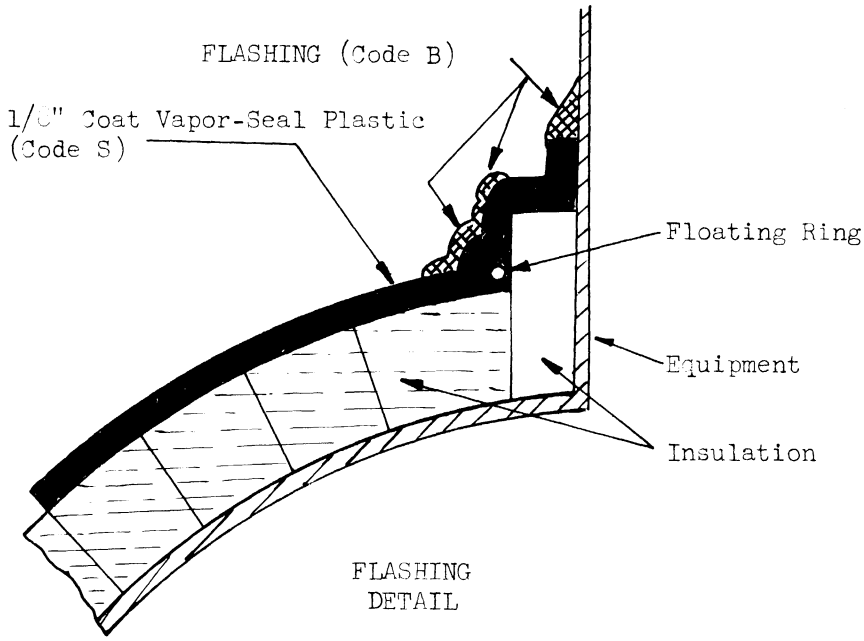

ANGLE IRON BAND
1/2" Dia. Holes for 3/8" Bolts in 1" & 1-1/2" Angles
5/8" Dia. Holes for 1/2" Bolts in 2" & 3" Angles
3/4" Dia. Holes for 5/8" Bolts in 4" Angles
(For Size of Angles see Table III)

VIEW OF HEAD
SHOWING ARRANGEMENT OF WIRES
OVER EACH LAYER OF CORK

Figure 25

CORK INSULATION ON HEADS OF CYLINDRICAL EQUIPMENT
(Code 6A)

Note: Code 6B is applied as shown above except wood skewers are not used.




FLASHING
DETAIL

DETAIL A
BRACKET SUPPORT

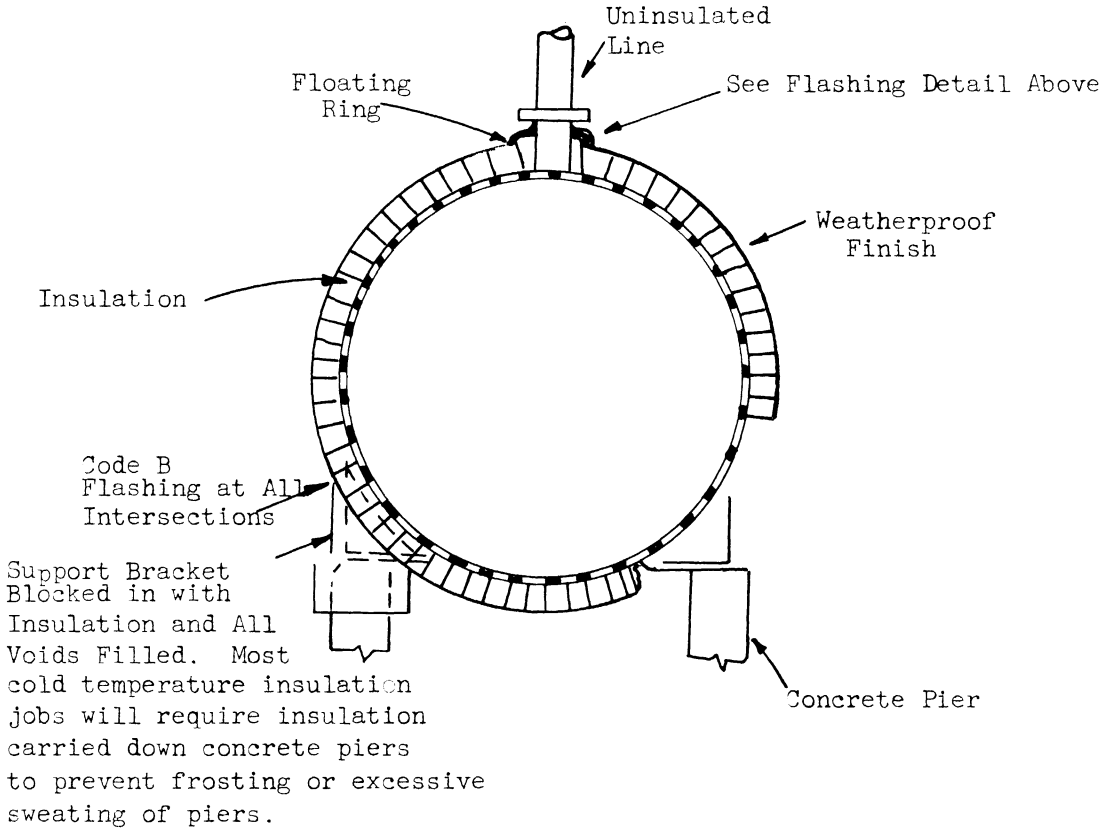
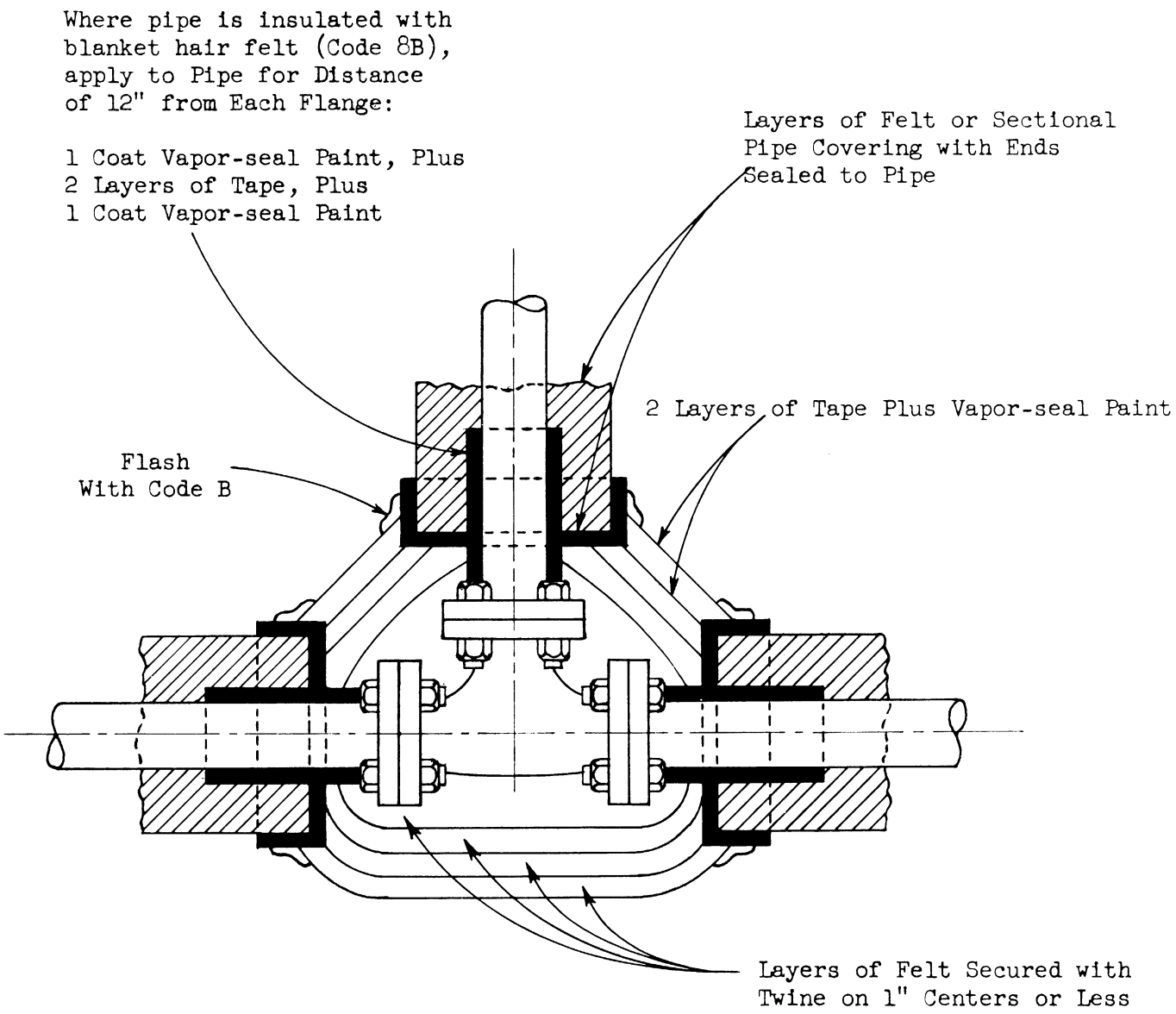



**Figure 26**

SECTION THRU CYLINDRICAL EQUIPMENT
CODE 6A OR 6B INSULATION - TYPE EE FINISH




(FINISH NOT SHOWN)

**Figure 27**

HAIR FELT ON FITTINGS

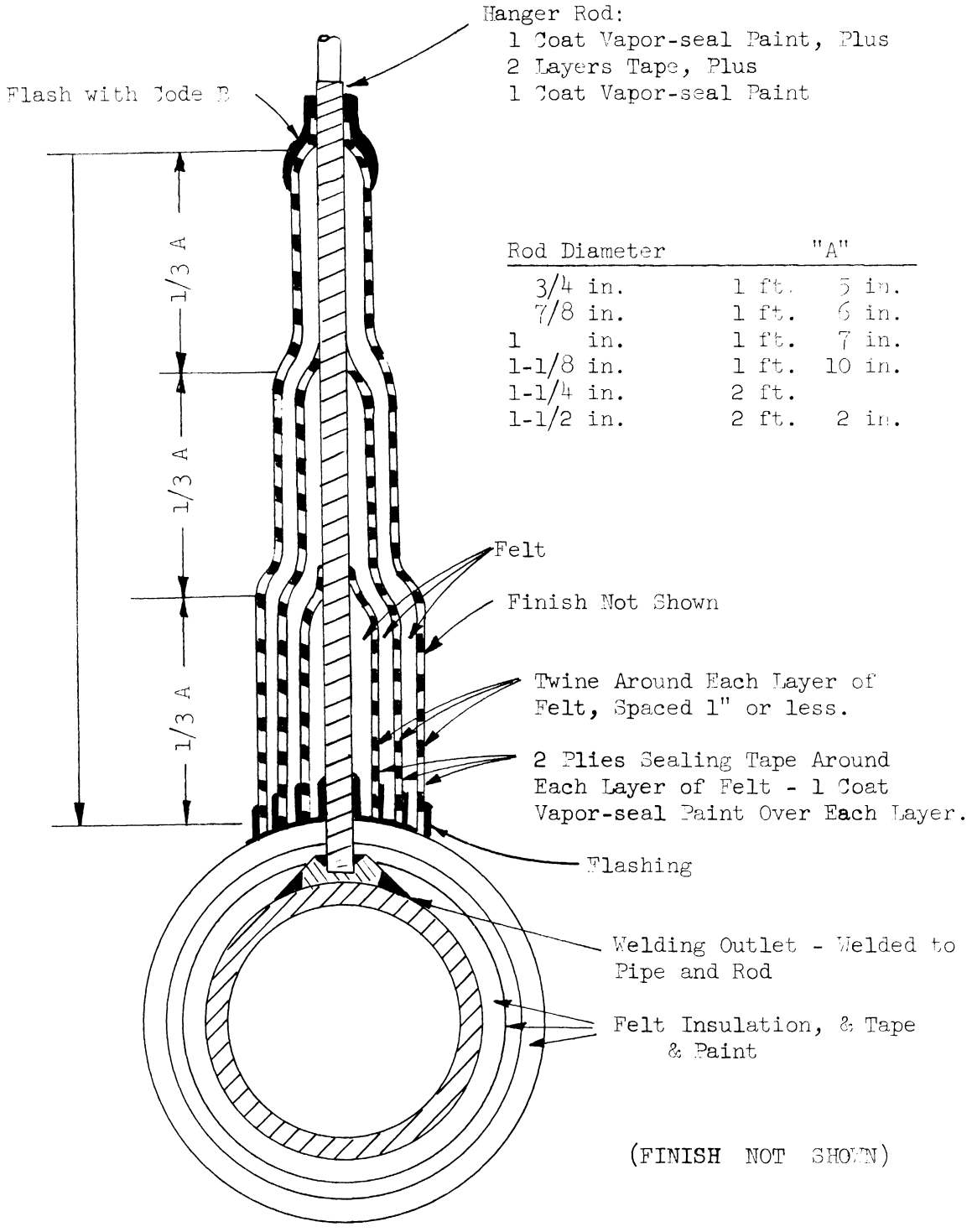
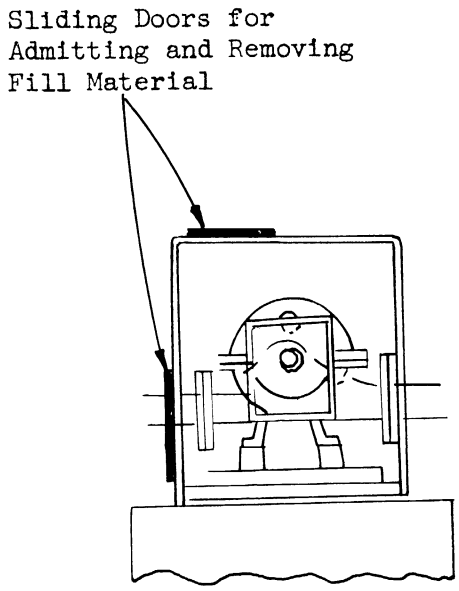



**Figure 28**

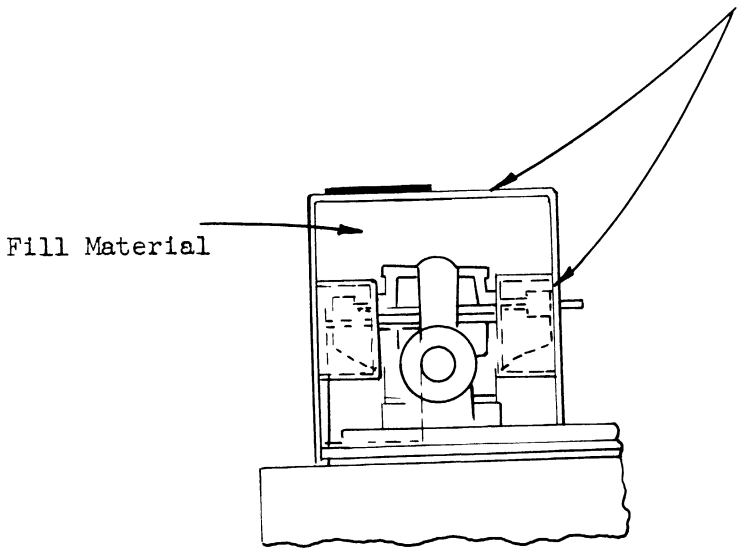
FELT ON HANGER ROD

STANDARD THERMAL INSULATION




END VIEW

Sheet Metal Box (Usually #12 Gage)
Enclosing Entire Pump Except Bearings




SIDE VIEW
(Plate on Near Side Removed for Illustration)

**Figure 29**

BRINE PUMP INSULATED WITH FILL MATERIAL
(CLASS 10) INSULATION

APPENDIX C

DEFINITIONS

Lags are segments or narrow curved blocks of insulation generally meaning vegetable cork shaped or cut to fit the contour of curved surfaces.

Cements are fibrous and/or fine powders in the dry form, which, when mixed with water and applied and dried, either afford substantial insulation quality or a hard, smooth finish.

Fill are loose fibrous, granular, or powdery insulations contained in panels or other tight enclosures. They constitute a separate class of insulating materials and the selection of one for a given use is contingent on the design of panel or container.

Finish is the protective coating applied over the outer surface of insulation.

Weatherproof Finish is a finish which will withstand the weather without sensible depreciation. As specified herein for low-temperature work on Classes 5, 6, 7, and 8, it shall also provide a positive vapor barrier.

Flashing, as used in this specification, is a weatherproof and vapor barrier seal of asphalt cut-back plastic applied at intersections and joints, where supports, piping, or other items protrude through the finish on insulation.

Section is one full piece of pipe covering 3 ft long. A Half-Section is one-half piece of pipe covering 3 ft long - not 18".

Segmental Covering is block insulation used as pipe covering.

Removable Cover is a cover constructed of insulation such that it may be removed and replaced without appreciable damage.

Tie Wire is a wire used for securing insulation in place.

Floating Ring is a ring of 1/4"-diameter steel wire, not attached to the surface being insulated, used to secure tie wires or bands.

Head Knuckle is a term applied to the portion of a dished head of cylindrical tank where the curvature is maximum.

## Engineering Terms

Unless otherwise specified:

Hot Temperatures - those higher than the dew point of the ambient air.

Low Temperatures - those below the dew point of the ambient air.

Sweat Temperatures - those above 32°F but not over the dew-point temperature of the ambient air.

Cold Temperatures - those below 32°F.

Vapor-tight shall mean the best vapor barrier obtainable with materials specified.

INDEX