International Association of Heat and Frost Insulators and Asbestos Workers

Blueprints, Codes and Specifications

ARCH411

Reading a Set of Plans Student Manual

International Association of Heat and Frost Insulators and Asbestos Workers
9602 Martin Luther King Highway
Lanham, MD 20706-1839

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If I can be of any further assistance, please give me a call.

With kindest regards, I remain

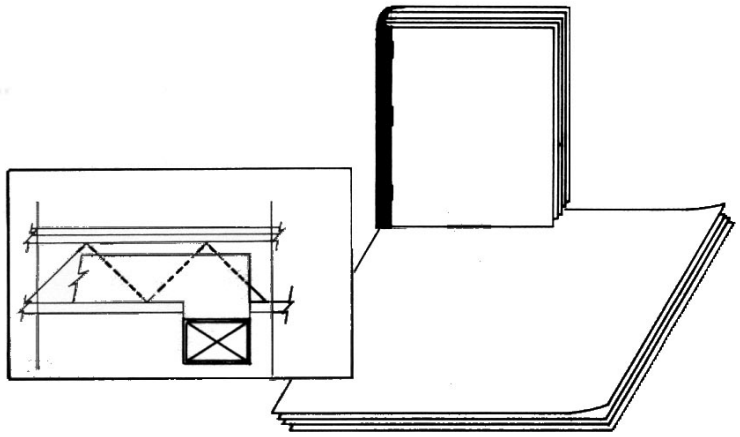
Fraternally yours,

Thomas A. Haun
Administrator

UNIT 1
INTRODUCTION TO READING A SET OF PLANS

WHEN YOU COMPLETE THIS UNIT
YOU WILL BE ABLE TO:

1. Describe the contents of a set of plans
2. Explain why insulators must read plans
3. Describe the organization of this manual.



INTRODUCTION

Knowing how to read a set of plans is extremely important if some of the work on a building is not done according to the set of plans, it may have to be torn out and done over.
This manual will cover this subject as much as possible to make you confident to read plans and specifications. When you finish the complete course, you will be able to work with the set of plans on the job with confidence.
The ability to read a set of plans is your key to advancement in the trade. If you know how to read plans and specifications, you can look forward to becoming a very productive, employable member. The sky is the limit and your services will be in demand after you have mastered these skills.
After reading and studying this information you should realize how important a good understanding of blueprint and specification reading is to the heat and frost insulation mechanic.

BASIC INFORMATION

The **set of plans** for a building is the official document that describes how the building is to be constructed. The contractor makes the cost estimate based on the information from the set of plans. The insulator must do the work as it is shown on the plans.

The set of plans has to be followed carefully. If material used on a job is different from that specified in the plans, the building owner has the right to require that the work be torn out and done as specified. If the insulator covers the wrong piping, the insulation contractor is still responsible to cover the piping shown on the plans. In short, to do the work **quickly** and **properly**, the insulator must be able to read the set of plans

To read the set of plans, you have to know how information is organized. You have to know what information is found in the book of specifications and what is found in the drawings. If you need information from the drawings, you can't just shuffle through all the sheets until, by luck, you find the proper one. You have to know which sheets are likely to have the information, and you have to be able to find those sheets quickly.

You have to know when numbers and letters on a sheet indicate that more information is on other sheets. And you have to know how to find those other sheets.

You also have to know how to read drawings when you find them. This means knowing how to interpret sectional views, plans, elevations, schematics, and isometric drawings. This manual will explain the things to know in order to read plans and specifications accurately and be an asset to your trade. More important, it will give you a lot of practice in using plans and specifications. We need this knowledge so that anyone of us is **capable** of running a job, large or small with the **desired results.**

Remember what your goal is – you need to **learn the material**, not just get a grade. You can spend energies trying to outguess the instructor and memorizing material just long enough to pass the test and get a good grade. But this won't give you the knowledge you need on the job. A good grade makes you feel good for a couple of days, but **learning** is **money in your pocket for the rest of your working life.** Concentrate on really learning the material so it can be applied on the job, and the grades will take care of themselves.

Once you are proficient in the execution of this work it gives you a great sense of **accomplishment, pride and self-worth.** This will also make you more **competitive** and **successful**, which is very **important** to our industry in **today's market.**

A SET OF PLANS

The names used to describe a set of plans vary and are often used loosely – and sometimes incorrectly. However, you should learn the proper terms.

You may hear the terms "blueprints" or "prints" used. These are old terms for building drawings. The term **"blueprints**" was used because the old method of duplicating drawings produced blue paper with white lines on it. These are now called "**drawings".**

TYPES OF PRINTS:

There are several types of prints in use today in addition to the most conventional blueprint. One type that is very accurate because it is developed by a dry process, are **ozalid** prints. This type of blueprint comes on a white background, with either blue, black or brown lines. There are numerous printing or reproduction methods, photographic reduction or enlargement processes, lithographic printing etc.

We in the construction trade however, identify best with the most used blue or black-line print or drawing. These blueprints are exact copies of the original drawings, which are **kept by the architect.**

All trades involved in the construction project get copies for a fee or deposit from the bid-depositories office. These sets are called **WORKING DRAWINGS.**

In this manual, we will use the following terms, which are generally accepted and understood in the industry. Figure 1 illustrates these terms.

A **line drawing** is an individual drawing of a part of a building. Examples of line drawings are detail drawings, elevations, and sectional views.

A **sheet** is a single sheet of paper with a drawing or many different drawings.

A **set of drawings** is made up of a number of sheets. The number of sheets in a set of drawings depends on the size of the building. For large buildings, there can easily be over 100 sheets in a set of drawings.

Industrial projects can have many sets of drawings and specifications each, and therefore it is very important to keep order and separation of the various sets. For example in a Pulp-Mill we could have a set for the power boiler, the bleach plant, the paper machine etc.

All these sets come with numerous details, elevations, sections and many isometric flow sheets. These drawings also contain line and nomenclature sheets showing every pipeline, its material makeup, the substance the line carries and the temperature of the substance. On the sheets we also find all type of valves even the type of pipe hangers that are being used together with all the fittings specified on the project.

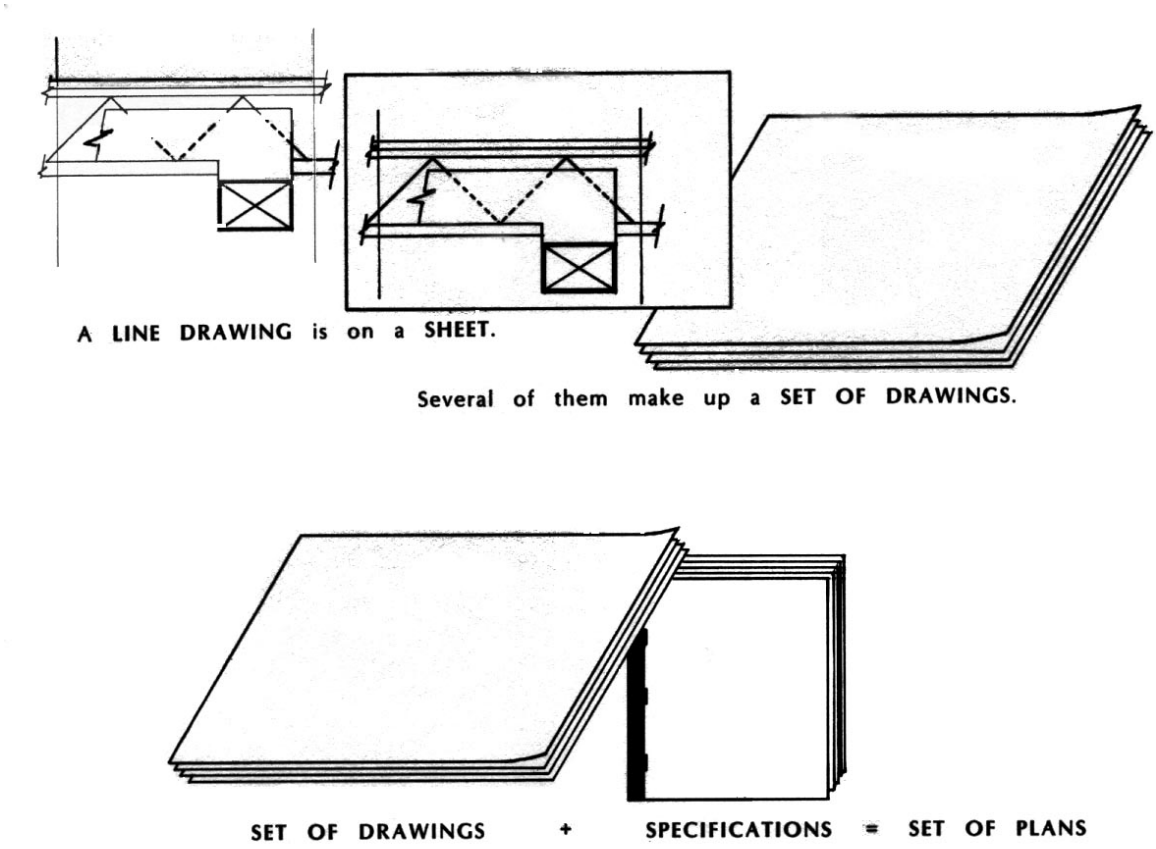


Fig. 1: Parts of a set of plans

The **specifications** are a manual that contains all the necessary information which cannot easily be shown on the set of drawings. It includes such things as contractor responsibilities, quality of workmanship, materials to be used, and the makes and models of equipment to be installed. The specifications are often called the **"specs**".

THE CONTENTS OF THIS MANUAL

Most of the units in this manual require you to find information in a set of plans. This gives you practical experience in finding your way through a set of plans – which you will have to do on the job. Your instructor will acquire a set to suite your local needs.

Each unit gives you the information you need and then gives you **Practice Problems** so that you can use the information. The **Review** at the end of the unit gives you a chance to see if you really understand the material in the unit. Your instructor may give you a short quiz at the end of a unit to check your learning.

ORGANIZATON

This manual is divided into four major sections:

Section A

Learning the Skills Needed to Read a Set of Plans

Section B

Finding Your Way Through a Set of Drawings

Section C

Practice in Using Drawings

Section D

Practice in working with Industrial Drawing Details and Specifications

These four sections are divided into units. Each unit gives you one step of learning.

SECTION A

LEARNING THE SKILLS NEEDED TO READ A SET OF PLANS

The first units in this section explain the general contents of the set of plans. Unit 4 explains how to use the architect's scale to measure drawings. In units 5, 6, and 7 you will learn to use drafting tools to make various kinds of drawings. Units 8 and 9 show you how to find and understand information in the set of drawings. In these units you will learn by doing – either by making a drawing or by finding information in the set of drawings.

The following units are included in **Section A**

1. Introduction to Reading a Set of Plans
2. Organization of a Set of Drawings
3. Specifications
4. Scaling
5. Understanding Plans and Elevations
6. Sectional Views
7. Isometric Drawings
8. References and Notes
9. Symbols Abbreviations

SECTION B

FINDING YOUR WAY THROUGH A SET OF DRAWINGS

The units in this section show you the contents of the different types of drawings. They give you practice in finding your way through a set of drawings easily and quickly. Unit 14 explains how a mechanical system works so that you can understand the mechanical drawings.

The following units are included in **Section B**

10. Architectural Drawings
11. Structural Drawings
12. Plumbing Drawings
13. Electrical Drawings
14. Understanding the Mechanical System
15. Mechanical Drawings

SECTION C:

PRACTICE IN USING DRAWINGS

The units in this section have practical problems, such as determining the insulation materials to be used and methods of installation.

The following units are included in **Section C:**

16. Reading Ductwork
17. Reading Piping
18. Practical Project with a Duct System
19. Practical Project with a Piping System

SECTION D:

PRACTICE WORKING WITH INDUSTRIAL DRAWINGS AND SPECIFICATIONS

The units in this section provide a basic understanding of how to work with **industrial specifications** and drawings that we encounter in our trade. We review the various scales that are used in our industry and how they actually work.

The Nomenclature or Line-sheets show us how they connect our work to the specifications. We will also learn how each industrial project has its own set of specifications to suit the specific needs of the project.

As a bonus we even get learn a little about the metric system and we try our hand at conversions, which is a nice little math project.

The various details will give us a great understanding of an **Industrial Project** and make us more self assured in the execution of our work on any jobsite.

The following units are included in **Section D:**

20. Deaerator Project exercise
21. Manufacturers Specifications
22. Nomenclature or Line Sheets with Isometric Flow-sheets
23. Plan, Section and Elevation Details
24. Pulp-Mill Tank insulation and jacketing details with specifications
25. Typical specifications for Industrial Projects
26. Measurement Converting Exercise (Metric and Imperial).

REVIEW PROBLEMS

Matching: In the blank provided, write the letter corresponding to the best answer.

_____1. Set of plans	A. Set of drawings plus specifications
_____2. Line drawing	B. Contains information not on drawings
_____3. Specifications	C. A single drawing
_____4. Sheet	D. Contains several sheets of drawings
_____5. Set of drawings	E. Contains one or more line drawings

Identification

Using the four sections below, (write A, B, C or D), in the blank provided to indicate which sections of the manual contain the information described.

Section A
Learning the Skills Needed to Read a Set of Plans

Section B.
Finding Your Way Through a Set of Drawings

Section C.
Practice in Using Drawings

Section D.
Practice Working with Industrial Drawings and Specifications

_____ 6. How a set of plans is organized
_____ 7. Practical HVAC projects
_____ 8. What an electrical drawing looks like
_____ 9. What is a manufacturers specification
_____ 10. What are mechanical drawings?
_____ 11. What is a sectional drawing?
_____ 12. How to read HVAC piping
_____ 13. What a nomenclature sheet is
_____ 14. How to make an isometric drawing
_____ 15. What is a flow sheet

UNIT 2
ORGANIZATION OF A SET OF DRAWINGS

WHEN YOU COMPLETE THIS UNIT
YOU WILL BE ABLE TO:

1. List the six major divisions in a set of drawings.
2. Tell what division a sheet belongs to by the letter in the title block.

C	**CIVIL - DRAWINGS**
A	**ARCHITECTURAL - DRAWINGS**
S	**STRUCTTURAL - DRAWINGS**
P	**PLUMBING - DRAWINGS**
M	**MECHANICAL - DRAWINGS**
E	**ELECTRICAL - DRAWINGS**

INTRODUCTION

A **set of plans** consists of the **set of drawings** and the **specifications.**

Specifications are covered in Unit 3. This unit explains the most common organization of a set of drawings and what some of the variations may be. Knowing the organization of a set of drawings is necessary in order to find information easily and quickly.

For a large commercial building, the set of drawings may consist of many sheets. You will need to obtain information from only a few of these sheets. Therefore, you have to understand how a set of drawings is organized in order to find the sheets you need quickly. The insulator typically needs the following information:

1. The location of various rooms
2. The location of piping and duct runs
3. Which runs of piping and duct are to be insulated
4. Lengths of runs
5. Duct and piping sizes
6. The available clearance for working after ductwork or piping is installed
7. Whether piping or duct to be insulated is concealed or exposed

C	CIVIL DRAWINGS	Site and utilities. May have a different title, such as site plan (SP)
A	ARCHITECTURAL DRAWINGS	Building arrangements, such as floor plans and elevations.
S	STRUCTURAL DRAWINGS	Building construction, such as roof construction and foundations.
P	PLUMBING DRAWINGS	Plumbing lines such as building hot and cold water supplies.
M	MECHANICAL DRAWINGS	HVAC mechanical rooms, ducts and piping for HVAC systems.
E	ELECTRICAL DRAWINGS	Electrical systems for lighting and power supplies.
Special Sheets		
ME	MECHANICAL-ELECTRICAL	Electrical system for controls
FP	FIRE PROTECTION	Sprinkler system and other fire protection devices.
FS	FOOD SERVICE	Kitchen equipment

Fig.1: Standard divisions for a set of drawings

ORGANIZATION OF DRAWINGS

Architects have different styles of drawing and different reference systems. However, they commonly arrange the sheets according to the building systems (Plumbing, Mechanical, Electrical, Structural). The sheets in a set of drawings are generally arranged in the following standard divisions:

- **Civil (site and utilities)**
- **Architectural**
- **Plumbing**
- **Mechanical**
- **Electrical**
- **Structural**

Each division is identified by a letter (Fig. 1), and each sheet in the division is identified by a number. For example, the first architectural sheet is A-1 and the second architectural sheet is A-2. The letter and number are usually on the bottom right corner of each sheet. Therefore you can leaf through the edge of the set of drawings until you locate the proper sheet. This means you don't have to turn each large sheet separately, and can avoid wasting valuable time.

The letter and number, along with the title of the sheet, are shown in a title block (Fig.2) which is usually in the lower right corner of the sheet. The title block in Fig.2 is for sheet M-4, so it identifies the forth sheet of the mechanical drawings. We can also see the various dates which means that changes had been made to the drawing. You can not afford to miss this information!!

LIST OF SHEETS

The first or second sheet in a set of drawings will probably contain a list of the sheets included. When you have a new set of drawings to work with, one of the first things to do is to find this list of sheets so that you know what is included in the set of drawings and how to find a particular sheet. If it is a small set of plans and there is no list of sheets, look over the title blocks for all the sheets to see what is included and to see how the set of drawings is organized.

The number of sheets in each division will vary with the size of the job. For a small building, there may be only two or three architectural sheets while a large building will have several times that number.

For a small commercial job there may be only one page that involves our work. The specifications and the drawings could all be on the same page. When we are working on this type of a project it is especially important to check for any **notes,** they could make all the difference in the outcome with our insulation contract. Remember when looking at the drawing number always **check the date,** this is most important. If for example, the date on the page is later than the date the contract was signed, we have to look for additional pricing, if the changes involve our work, and were **not included** in the bid!!

Create practice problems from your set of drawings
(The space below is for you to create your own practice problems),
from types of sheets, like Architectural, Structural, Plumbing, Mechanical, etc.

Fig. 2: Part of a title block

CIVIL SHEETS

Civil sheets **(C)** show the site and location of utilities, such as phone, gas, and electricity, that will be connected to the building. These sheets may have some other title, such as **site plan (SP).** They contain information about the site, such as:

- Survey of the site, both before and after construction
- Location of utility hookups and utility tunnels
- Plot plan, showing how the site is related to nearby property
- Landscape plans

ARCHITECTURAL SHEETS
(A-1, A-2, etc.)

Architectural sheets contain information about the building, such as:

- The arrangement of the rooms in the building
- How the building is located on the land
- Information on the exterior and interior of the building

STRUCTURAL SHEETS
(S-1, S-2, etc.)

Structural sheets give details on how the building is constructed, such as :

- How the foundation is to be built
- How the roof is constructed
- Information about any structural steel in the building

PLUMBING SHEETS
(P-1, P-2, etc.)

The plumbing sheets provide information on the plumbing systems of the building, such as:

- Sewage lines
- Hot water and cold water systems
- Drainage lines

Steam lines and hot water lines for the HVAC system are not shown on the plumbing sheets. They are shown on the mechanical sheets.

MECHANICAL SHEETS
(M-1, M-2, etc.) or (H-1, H-2, etc)

Mechanical sheets contain information about the HVAC system, such as:

- How the mechanical room is arranged
- How the HVAC duct is run
- How the HVAC piping is run

ELECTRICAL SHEETS
(E-1, E-2, etc.)

Electrical sheets contain information on the electrical systems in the building, such as:

- Locations of electrical outlets
- Location, size, and types of switch boxes
- Where heat-tracing to keep pipes from freezing is used
- Location of emergency generator (Or it may be on mechanical sheets)
- Location and types lighting fixtures (like Radiant Heating Coils)

SPECIAL SHEETS

Special sheets may be added that show special systems in the building. The letter codes used for special sheets vary, but common codes are given in the listing below. The following are special sheets that may require insulation:

Fire Protection sheets (**F or FP**) show the sprinkler system and other fire safety devices. The sprinkler system may need insulation to prevent condensation or protect it from freezing.

Mechanical-Electrical sheets (**ME**) show the automatic control system for such things as refrigeration units, pumps, fans, and boilers. The location of controls may affect how insulation is installed.

Food Service sheets (**FS**) show the details of kitchen equipment. Insulation may be needed on steam pipes to steam kettles, stove hoods (including kitchen exhaust ductwork), hot water piping, and other features.

Refrigeration sheets (**MR or R**) show the refrigeration system. This is usually shown on the mechanical sheets, but a very large or specialized system may have a separate division.

Industrial projects or other special buildings may have special sheets for other particular needs. Be sure to look at the list of sheets to see if there are any special sheets that may include insulation.

Manufacturer's sheets contain usually special items supplied to the project and have to be followed very carefully to see about our involvement on the job.

Make up your own **practice problems** below from the information at hand.

VARIATIONS

It is important to understand that the organization of drawings just described is the most common method used. However, it is not the only method. In general, all the architects follow the organization of the five major divisions, but the letters, names, and numbering systems may vary. For example, mechanical sheets are generally identified by the letter **M.** However some architects use the letter **H** (for heating) instead. Some architects simply number the sheets (Sheet 1, Sheet 2, etc.) and have a list of sheets on the title sheet.

Additional sheets may be inserted at various places if they are needed. For example, a set of drawings may have a sheet marked **MP** which is a **Mechanical-Plumbing Plot Plan**. This sheet shows where the various hot water, chilled water, sewage, and drainage lines are to be run on the plot of land. The title of any special sheet is given in the title block along with the letter and number of the sheet.

NEWER NUMBERING SYSTEM

A newer method of sheet arrangement still follows the standard arrangement of the six divisions (Architectural, Civil, Structural, Plumbing, Mechanical, and Electrical). However, two numbers are given, such as A3.1, A3.2, A3.3, etc. The **A** means **architectural** drawings. The number **3** is given to **elevations** in the architectural division. A3.1 is the first sheet of elevations, A3.2 is the second sheet of elevations, and A3.3 is the third sheet of architectural elevations. The number **4** is given to **plans** in the architectural division. A4.1 is the first sheet of architectural plans, and A4.2 is the second sheet of architectural plans.

This method makes it easier for the architect to insert sheets in the proper order. For example, if two sheets of elevations have been drawn (A3.1 and A3.2), a third elevation sheet (A3.3) can be inserted later in the proper order without having to renumber the entire division of architectural sheets.

REVIEW PROBLEMS

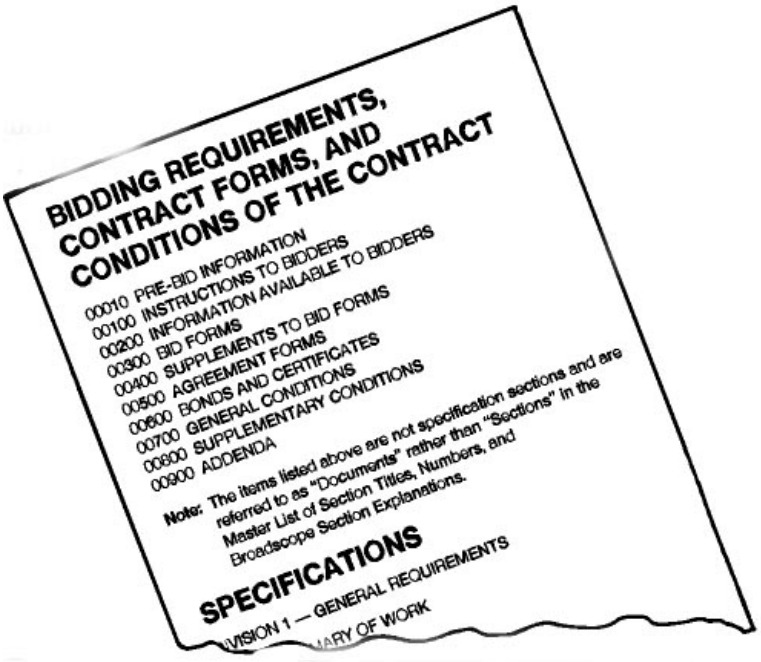
Matching: In the blank provided, write the letter corresponding to the best answer.

_____ 1. Architectural drawings	A. Show the building water systems
_____ 2. Structural drawings	B. Show special systems in the building
_____ 3. Plumbing drawings	C. Drawings of kitchen equipment
_____ 4. Mechanical drawings	D. Show the HVAC system
_____ 5. Electrical drawings	E. Show the roof construction
_____ 6. Civil drawings	F. Show the location of light fixtures
_____ 7. Special sheets	G. Drawings of fire protection system
_____ 8. FP sheets	H. Contain floor plans and elevations
_____ 9. FS sheets	I. Show where utilities are located

UNIT 3
SPECIFICATIONS

WHEN YOU COMPLETE THIS UNIT YOU WILL BE ABLE TO:

1. Use the specifications to find information on a construction project.


BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT

00010 PRE-BID INFORMATION
00100 INSTRUCTIONS TO BIDDERS
00200 INFORMATION AVAILABLE TO BIDDERS
00300 BID FORMS
00400 SUPPLEMENTS TO BID FORMS
00500 AGREEMENT FORMS
00600 BONDS AND CERTIFICATES
00700 GENERAL CONDITIONS
00800 SUPPLEMENTARY CONDITIONS
00900 ADDENDA

Note: The items listed above are not specification sections and are referred to as "Documents" rather than "Sections" in the Master List of Section Titles, Numbers, and Broadscope Section Explanations.

SPECIFICATIONS

DIVISION 1 — GENERAL REQUIREMENTS

SUMMARY OF WORK

INTRODUCTION

A set of plans is made up of two parts – the set of drawings and the **specifications**. Both of these are equally important. The specifications are a collection of all the information about the construction project that cannot be conveniently included in the drawings. A set of drawings combined with the specifications work together to define a project. However, if the drawings and the specifications ever disagree over some point, the **specifications** must be followed.

Specifications are particularly important to the insulator because much of the information regarding the insulators' work is in the specifications rather than in the set of drawings.

The **specifications** present all the necessary information about the project that cannot be included on the drawings. The specifications are commonly referred to as specs. The architect who designs the project put together the book of specifications.

The most important thing for you to understand about specifications is they are a **legal document**. Your contractor has signed an agreement that the work on the job will be performed exactly as specified. If you make changes in the material or in the method of installation without getting written approval, the architect or building owner can legally require that the work be removed and installed according to specifications.

For example, while you are on the job it may be obvious to you that using a different insulation than the one specified will give a better and lower cost job. You are taking a great risk if you make the substitution without a change order. Generally the mechanic must get approval from the job foreman, who will be responsible for getting a change order. If you do the work without approval, your contractor may have to pay for removing all the insulation and re-installing it according to specifications.

The specifications contain two kinds of information. The first part covers legal matters, and a second part of the book is the technical specifications, which cover the materials and methods to be used on the project.

LEGAL MATTERS

The legal requirements of a job are very important for the **owner**, the **architect,** the **engineer**, and the **contractor.** The first part of the specifications deals with everything that can be covered under the following headings:

- Pre-bid Information
- Instructions to Bidders
- Information Available to Bidders
- Bid Forms
- Supplements to Bid Forms
- Agreement Forms
- Bonds and Certifications
- General Conditions
- Supplementary Conditions
- Addenda

One of the first sections in the specifications concerns bidding requirements. This section will include an advertisement for bids that describes the scope of the project. A copy of the advertisement for bids is published where it will reach contractors that can bid on the project. The section on bidding requirements will specify how a contractor is to bid on a job and will contain the bidding deadlines.

The contract for the project is included in the specifications. It is the agreement between the owner and the contractor concerning the work that has to be done. Once the contract is signed, it is legally binding on both owner and contractor.

The general and supplementary conditions explain the duties and rights of those concerned with the contract. The general conditions follow a standard format that fits most contracts. The supplementary conditions add any particular variations required by local codes or the conditions of the project.

For Industrial Projects we have what is called (Pre-job) conferences included in the specifications. These meetings are usually attended on the jobsite by everyone interested in the bid.

TECHNICAL SPECIFICATIONS

The **technical specifications** define the materials and methods to be used for every part of the construction project. Anyone who is ordering material or planning installations must be able to find the necessary information in the technical specifications.

A sample of the technical specifications from an actual set of plans is included at the end of this unit.

IMPORTANT: If the specifications and drawings disagree, the specifications are legally binding and must be followed.

Usually there is no conflict, and the drawings and specs work hand in hand. But if there is a difference between the two, you **must** follow the **specifications**.
To avoid confusion in the organization of the technical specifications, the Construction Specifications Institute **(CSI)** has set up a standard format.

It includes these **16 divisions**:

1. General Requirements
2. Site Work
3. Concrete
4. Masonry
5. Metals
6. Wood and Plastics
7. Thermal and Moisture Protection
8. Doors and Windows
9. Finishes
10. Specialties
11. Equipment
12. Furnishings
13. Special Construction
14. Conveying Systems
15. Mechanical
16. Electrical

Project coordination is covered in Division 1. - General requirements. This division sets procedures for coordinating work among the various crafts. This section is very important for every group (architects, engineers, construction managers, etc.) and craft (insulators, sheet metal workers, electricians, etc.) working on the job.

Each of these divisions has many subsections and each subsection may have a five digit number assigned to it. A list of the broad subsections set up by **CSI** is given in **Fig.1.**

The first two digits of the number refer to the division. For example, 07100 Waterproofing and 07250 Fireproofing both belong to Division 7. Thermal and Moisture Protection, Subsection 15250 Mechanical Insulation and 15650 Refrigeration both belong to Division 15, Mechanical.

The last three digits refer to a particular subsection. The broad subsections listed in **Fig.1** may be all that is needed (or even much more than is needed) for a medium or small project. A large project might use even more subsections.

Many more subsection numbers have been assigned by **CSI (Construction Specifications Institute).** The numbering system is designed so that more subsections can be added if necessary. The architect who puts together the specifications decides which headings are needed for a particular project.

If you know the organization of the divisions, it will be much easier to find information that you need. If you are reviewing the specs to find the work that will be done by the insulators, you should know where the insulator's work is likely to be found.

Division 15, Mechanical, is likely the most important division for an insulator. However, some required insulation may be found in other areas. For example, Division 16, Electrical, would specify if insulation is needed for the emergency generator exhaust. It would also indicate if electrical resistance heating **(heat tracing)** has to be added to piping before the insulation is installed. A contractor doing **asbestos abatement** work or firestopping would look in various areas to find the specifications that would apply to the particular job. Insulation for vibration isolation and sound attenuation may be required. Therefore, the estimator or contractor who uses the technical specifications has to know them well.

Specifications vary in how detailed they are:

1. A particular brand and type of insulation may be required.
2. A particular brand and type of insulation may be listed with the phrase **"or equal,"** "or **similar**," or **the like**. This means that an item of equal quality (if submitted and approved) can be used instead.
3. A number may be given for a FS **(federal specifications)** standard or for an ASTM **(American Society for Testing and Materials)** standard. This means that the insulation must meet the standard specified.

The National Insulation Association (NIA) publishes the **Guide to Insulation Product Specifications**. This guide lists the code numbers for **ASTM** standards or federal standards, describes the **materia**l, and gives the **scope** of the **operating conditions** that apply. Manufacturers of particular materials may also be listed.

BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT

00010 PRE-BID INFORMATION
00100 INSTRUCTIONS TO BIDDERS
00200 INFORMATION AVAILABLE TO BIDDERS
00300 BID FORMS
00400 SUPPLEMENTS TO BID FORMS
00500 AGREEMENT FORMS
00600 BONDS AND CERTIFICATES
00700 GENERAL CONDITIONS
00800 SUPPLEMENTARY CONDITIONS
00900 ADDENDA

Note: The items listed above are not specification sections and are referred to as "Documents" rather than "Sections" in the Master List of Section Titles, Numbers, and Broadscope Section Explanations.

SPECIFICATIONS

DIVISION 1 -- GENERAL REQUIREMENTS

01010 SUMMARY OF WORK
01020 ALLOWANCES
01025 MEASUREMENT AND PAYMENT
01030 ALTERNATES/ALTERNATIVES
01035 MODIFICATION PROCEDURES
01040 COORDINATION
01050 FIELD ENGINEERING
01060 REGULATORY REQUIREMENTS
01070 IDENTIFICATION SYSTEMS
01090 REFERENCES
01100 SPECIAL PROJECT PROCEDURES
01200 PROJECT MEETINGS
01300 SUBMITTALS
01400 QUALITY CONTROL
01500 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
01600 MATERIAL AND EQUIPMENT
01650 FACILITY STARTUP/COMMISSIONING
01700 CONTRACT CLOSEOUT
01800 MAINTENANCE

DIVISION 2 -- SITEWORK

02010 SUBSURFACE INVESTIGATION
02050 DEMOLITION
02100 SITE PREPARATION
02140 DEWATERING
02150 SHORING AND UNDERPINNING
02160 EXCAVATION SUPPORT SYSTEMS
02170 COFFERDAMS
02200 EARTHWORK
02300 TUNNELING
02350 PILES AND CAISSONS
02450 RAILROAD WORK
02480 MARINE WORK
02500 PAVING AND SURFACING
02600 UTILITY PIPING MATERIALS
02660 WATER DISTRIBUTION
02680 FUEL AND STEAM DISTRIBUTION
02700 SEWERAGE AND DRAINAGE
02760 RESTORATION OF UNDERGROUND PIPE
02770 PONDS AND RESERVOIRS
02780 POWER AND COMMUNICATIONS
02800 SITE IMPROVEMENTS
02900 LANDSCAPING

DIVISION 3 -- CONCRETE

03100 CONCRETE FORMWORK
03200 CONCRETE REINFORCEMENT
03250 CONCRETE ACCESSORIES
03300 CAST-IN-PLACE CONCRETE
03370 CONCRETE CURING
03400 PRECAST CONCRETE
03500 CEMENTITIOUS DECKS AND TOPPINGS
03600 GROUT
03700 CONCRETE RESTORATION AND CLEANING
03800 MASS CONCRETE

DIVISION 4 -- MASONRY

04100 MORTAR AND MASONRY GROUT
04150 MASONRY ACCESSORIES
04200 UNIT MASONRY
04400 STONE
04500 MASONRY RESTORATION AND CLEANING
04550 REFRACTORIES
04600 CORROSION RESISTANT MASONRY
04700 SIMULATED MASONRY

DIVISION 5 -- METALS

05010 METAL MATERIALS
05030 METAL COATINGS
05050 METAL FASTENING
05100 STRUCTURAL METAL FRAMING
05200 METAL JOISTS
05300 METAL DECKING
05400 COLD FORMED METAL FRAMING
05500 METAL FABRICATIONS
05580 SHEET METAL FABRICATIONS
05700 ORNAMENTAL METAL
05800 EXPANSION CONTROL
05900 HYDRAULIC STRUCTURES

DIVISION 6 -- WOOD AND PLASTICS

06050 FASTENERS AND ADHESIVES
06100 ROUGH CARPENTRY
06130 HEAVY TIMBER CONSTRUCTION
06150 WOOD AND METAL SYSTEMS
06170 PREFABRICATED STRUCTURAL WOOD
06200 FINISH CARPENTRY
06300 WOOD TREATMENT
06400 ARCHITECTURAL WOODWORK
06500 STRUCTURAL PLASTICS
06600 PLASTIC FABRICATIONS
06650 SOLID POLYMER FABRICATIONS

DIVISION 7 -- THERMAL AND MOISTURE PROTECTION

07100 WATERPROOFING
07150 DAMPPROOFING
07180 WATER REPELLENTS
07190 VAPOR RETARDERS
07195 AIR BARRIERS
07200 INSULATION
07240 EXTERIOR INSULATION AND FINISH SYSTEMS
07250 FIREPROOFING
07270 FIRESTOPPING
07300 SHINGLES AND ROOFING TILES
07400 MANUFACTURED ROOFING AND SIDING
07480 EXTERIOR WALL ASSEMBLIES
07500 MEMBRANE ROOFING
07570 TRAFFIC COATINGS
07600 FLASHING AND SHEET METAL
07700 ROOF SPECIALTIES AND ACCESSORIES
07800 SKYLIGHTS
07900 JOINT SEALERS

Fig. 1: CSI headings for specifications

DIVISION 8 -- DOORS AND WINDOWS

08100 METAL DOORS AND FRAMES
08200 WOOD AND PLASTIC DOORS
08250 DOOR OPENING ASSEMBLIES
08300 SPECIAL DOORS
08400 ENTRANCES AND STOREFRONTS
08500 METAL WINDOWS
08600 WOOD AND PLASTIC WINDOWS
08650 SPECIAL WINDOWS
08700 HARDWARE
08800 GLAZING
08900 GLAZED CURTAIN WALLS

DIVISION 9 -- FINISHES

09100 METAL SUPPORT SYSTEMS
09200 LATH AND PLASTER
09250 GYPSUM BOARD
09300 TILE
09400 TERRAZZO
09450 STONE FACING
09500 ACOUSTICAL TREATMENT
09540 SPECIAL WALL SURFACES
09545 SPECIAL CEILING SURFACES
09550 WOOD FLOORING
09600 STONE FLOORING
09630 UNIT MASONRY FLOORING
09650 RESILIENT FLOORING
09680 CARPET
09700 SPECIAL FLOORING
09780 FLOOR TREATMENT
09800 SPECIAL COATINGS
09900 PAINTING
09950 WALL COVERINGS

DIVISION 10 -- SPECIALTIES

10100 VISUAL DISPLAY BOARDS
10150 COMPARTMENTS AND CUBICLES
10200 LOUVERS AND VENTS
10240 GRILLES AND SCREENS
10250 SERVICE WALL SYSTEMS
10260 WALL AND CORNER GUARDS
10270 ACCESS FLOORING
10290 PEST CONTROL
10300 FIREPLACES AND STOVES
10340 MANUFACTURED EXTERIOR SPECIALTIES
10350 FLAGPOLES
10400 IDENTIFYING DEVICES
10450 PEDESTRIAN CONTROL DEVICES
10500 LOCKERS
10520 FIRE PROTECTION SPECIALTIES
10530 PROTECTIVE COVERS
10550 POSTAL SPECIALTIES
10600 PARTITIONS
10650 OPERABLE PARTITIONS
10670 STORAGE SHELVING
10700 EXTERIOR PROTECTION DEVICES FOR OPENINGS
10750 TELEPHONE SPECIALTIES
10800 TOILET AND BATH ACCESSORIES
10880 SCALES
10900 WARDROBE AND CLOSET SPECIALTIES

DIVISION 11 -- EQUIPMENT

11010 MAINTENANCE EQUIPMENT
11020 SECURITY AND VAULT EQUIPMENT
11030 TELLER AND SERVICE EQUIPMENT
11040 ECCLESIASTICAL EQUIPMENT
11050 LIBRARY EQUIPMENT
11060 THEATER AND STAGE EQUIPMENT
11070 INSTRUMENTAL EQUIPMENT
11080 REGISTRATION EQUIPMENT
11090 CHECKROOM EQUIPMENT
11100 MERCANTILE EQUIPMENT
11110 COMMERCIAL LAUNDRY AND DRY CLEANING EQUIPMENT
11120 VENDING EQUIPMENT
11130 AUDIO-VISUAL EQUIPMENT
11140 VEHICLE SERVICE EQUIPMENT
11150 PARKING CONTROL EQUIPMENT
11160 LOADING DOCK EQUIPMENT
11170 SOLID WASTE HANDLING EQUIPMENT
11190 DETENTION EQUIPMENT
11200 WATER SUPPLY AND TREATMENT EQUIPMENT
11280 HYDRAULIC GATES AND VALVES
11300 FLUID WASTE TREATMENT AND DISPOSAL EQUIPMENT
11400 FOOD SERVICE EQUIPMENT
11450 RESIDENTIAL EQUIPMENT
11460 UNIT KITCHENS
11470 DARKROOM EQUIPMENT
11480 ATHLETIC, RECREATIONAL, AND THERAPEUTIC EQUIPMENT
11500 INDUSTRIAL AND PROCESS EQUIPMENT
11600 LABORATORY EQUIPMENT
11650 PLANETARIUM EQUIPMENT
11660 OBSERVATORY EQUIPMENT
11680 OFFICE EQUIPMENT
11700 MEDICAL EQUIPMENT
11780 MORTUARY EQUIPMENT
11850 NAVIGATION EQUIPMENT
11870 AGRICULTURAL EQUIPMENT

DIVISION 12 -- FURNISHINGS

12050 FABRICS
12100 ARTWORK
12300 MANUFACTURED CASEWORK
12500 WINDOW TREATMENT
12600 FURNITURE AND ACCESSORIES
12670 RUGS AND MATS
12700 MULTIPLE SEATING
12800 INTERIOR PLANTS AND PLANTERS

Fig. 1: CSI headings for specifications (continued)

DIVISION 13 -- SPECIAL CONSTRUCTION

13010 AIR SUPPORTED STRUCTURES
13020 INTEGRATED ASSEMBLIES
13030 SPECIAL PURPOSE ROOMS
13080 SOUND, VIBRATION, AND SEISMIC CONTROL
13090 RADIATION PROTECTION
13100 NUCLEAR REACTORS
13120 PRE-ENGINEERED STRUCTURES
13150 AQUATIC FACILITIES
13175 ICE RINKS
13180 SITE CONSTRUCTED INCINERATORS
13185 KENNELS AND ANIMAL SHELTERS
13200 LIQUID AND GAS STORAGE TANKS
13220 FILTER UNDERDRAINS AND MEDIA
13230 DIGESTER COVERS AND APPURTENANCES
13240 OXYGENATION SYSTEMS
13260 SLUDGE CONDITIONING SYSTEMS
13300 UTILITY CONTROL SYSTEMS
13400 INDUSTRIAL AND PROCESS CONTROL SYSTEMS
13500 RECORDING INSTRUMENTATION
13550 TRANSPORTATION CONTROL INSTRUMENTATION
13600 SOLAR ENERGY SYSTEMS
13700 WIND ENERGY SYSTEMS
13750 COGENERATION SYSTEMS
13800 BUILDING AUTOMATION SYSTEMS
13900 FIRE SUPPRESSION AND SUPERVISORY SYSTEMS
13950 SPECIAL SECURITY CONSTRUCTION

DIVISION 14 -- CONVEYING SYSTEMS

14100 DUMBWAITERS
14200 ELEVATORS
14300 ESCALATORS AND MOVING WALKS
14400 LIFTS
14500 MATERIAL HANDLING SYSTEMS
14600 HOISTS AND CRANES
14700 TURNTABLES
14800 SCAFFOLDING
14900 TRANSPORTATION SYSTEMS

DIVISION 15 -- MECHANICAL

15050 BASIC MECHANICAL MATERIALS AND METHODS
15250 MECHANICAL INSULATION
15300 FIRE PROTECTION
15400 PLUMBING
15500 HEATING, VENTILATING, AND AIR CONDITIONING
15550 HEAT GENERATION
15650 REFRIGERATION
15750 HEAT TRANSFER
15850 AIR HANDLING
15880 AIR DISTRIBUTION
15950 CONTROLS
15990 TESTING, ADJUSTING, AND BALANCING

DIVISION 16 -- ELECTRICAL

16050 BASIC ELECTRICAL MATERIALS AND METHODS
16200 POWER GENERATION - BUILT-UP SYSTEMS
16300 MEDIUM VOLTAGE DISTRIBUTION
16400 SERVICE AND DISTRIBUTION
16500 LIGHTING
16600 SPECIAL SYSTEMS
16700 COMMUNICATIONS
16850 ELECTRIC RESISTANCE HEATING
16900 CONTROLS
16950 TESTING

Fig. 1: CSI headings for specifications (continued)

Functional specs or **application specs** are those that describe the operating conditions of the materials. For example, the specs may say that the insulation in a certain area must withstand impact or abrasion. Often insulation must be chosen to withstand certain temperatures. For example, the specifications can require an insulation for temperatures up to **450° F** or for a range from **40° F to 250° F**. For many industrial insulations the limits ranges are much higher can go up to thousands of degrees.

PRACTICE PROBLEMS

The following questions are based on the specifications at the end of this unit. Write the correct answer in the space provided below the question.

1. What three types of mechanical insulation are specified in section 15250 of the specifications?

   _____

2. What staples, bands, wires, and cements are to be used for pipe insulation?

   _____

3. What type of cellular glass insulation is to be used on ductwork?

   _____

4. What type of cellular glass insulation is to be used on pipes?

   _____

5. What kind of jacketing material is required for equipment insulation?

   _____

6. Where is insulation not required on plumbing lines?

   _____

7. Is insulation to be installed on pipe systems before or after the system is tested?

   _____

8. Can factory-cut insulation be used to cover valves and other fittings?

   _____

ADDENDA

An **addendum** is any change made to the drawings or the specifications. All of the addenda are put together in the front of the book of specs so that they won't be overlooked. (Just one is an **addendum;** more than one are **addenda**.)

Addenda are often needed because changes are required after a set of plans goes to the various agencies that must approve it.

IMPORTANT:

Be **sure** to **check** the **addenda** whenever you are **looking** for **information** in a **set of plans.** Information in an addendum **replaces** any earlier information. The most **recent** addendum is always the information that must be followed, so make sure to check for the date .We need to know if the addenda where made before or after the bid was signed, in order to keep from doing work **without getting paid for it**. This is something we can not afford, I hope you understand the importance of this fact, always make sure and check the date on the drawing and on the addendum, it is a must!!

CHANGE ORDERS

A **change order** is a written order for a change in the contract documents. It **must be signed by the architect, the owner, and the contractor**.

Change orders may be requested after the work on the project is already in progress. Change orders are usually requested by the architect or owner, but they can also be requested by the contractor. Any change that affects **costs and schedules** has to be considered carefully and agreed to by all parties who sign the contract.

REVIEW

Short Answer

Write the correct answer in the space provided below the question.

1. What are the two parts of a set of plans?

   _____

2. The specifications for a project call for all ductwork in the equipment room to be insulated, but the drawings do not indicate insulation on the equipment room ductwork. Should the insulation be added or not?

   _____

3. Which division of the technical specifications deals with the HVAC system?

   _____

4. Subsection 01035 is Modification Procedures. What division is it in?

   _____

5. Who has to sign a change order to make it legally binding?

   _____

6. In what section would you find any changes that have been made in the specifications?

   _____

7. Where would you find information about the bid requirements and deadlines?

   _____

8. Where would you find a copy of the contract for the project?

   _____

Answers to Practice Problems : (from page 26)

1. Piping system insulation Ductwork system insulation Equipment insulation

2. As recommended by insulation manufacturer for application indicated

3. FS HH-I-551, Type I.

4. FS HH-I-1751/3A, Type I, Class 4.

5. Pre-sized glass cloth material, not less than 7.8 ounces per square yard, except as otherwise indicated.

6. On exposed plumbing fixture runouts from faces of wall or floor fixture; on unions, flanges, strainers, flexible connections, and expansion joints.

7. After.

8. Yes.

Sample Specifications

Section 15250- Mechanical Thermal Insulation

PART 1- GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.02 SUMMARY

A. This section includes preformed, rigid and flexible pipe insulation; semirigid and flexible duct, plenum, and breeching insulation; blanket, board and block insulation; insulating cements; field applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:
   1. Section 07840 – **Firestopping** for firestopping materials and requirements for penetrations through fire and smoke barriers.
   2. Section 15081 – Metal Ducts for duct liner.
   3. Section 15060 – Hangers and Supports for pipe insulation shields and protection saddles.

1.03 DESCRIPTION OF WORK

A. Extent of thermal insulation required by this section is indicated on drawings, and by requirements of this section.
B. Type of mechanical insulation specified in this section include the following:

   1. Piping System Insulation:

      a. Domestic Water Piping Systems
      b. Storm Water Piping Systems
      c. Steam Piping Systems
      d. Hot/Chilled Water Piping Systems
      e. Make-up Water Piping Systems

2. Ductwork System Insulation
    a. Cold Ductwork
    b. Dual Temperature Ductwork
    c. Air Plenums and Equipment Housings

3. Equipment Insulation:
    a. Hot Surfaces of Mechanical Equipment
    b. Cold Surfaces of Mechanical Equipment
    c. Funnel drains
    d. Insulation furnished as part of factory fabricated equipment or ductwork, are specified in other Division—15 sections.

1.04 QUALITY ASSURANCE

A. Installer: work shall be preformed by specialists with a minimum of 3 years experience on projects with mechanical insulations similar to that required for this project. Program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test Response Characteristics: As determined by testing materials identical to those specified in this section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacketing materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
    1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
    2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.05 SUBMITTALS

A. Product Data: Submit Manufacture's specifications and insulation instruction for each type of mechanical insulation. Submit schedule showing manufactures product number, thickness and furnished accessories for each mechanical system requiring insulation.
B. Maintenance Data: Submit maintenance data ad replacement material lists for each type of mechanical insulation. Include this data in maintenance manual.
C. Samples: Submit 1'-0" sample of each piping insulation type required, and 1'-0" x 1'-0" sample of each duct equipment insulation type required.

1.06 REFERENCES – QUALITY ASSURANCE

A. Federal Specifications (FS) standards.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site with manufacture's stamp or label affixed showing fire hazard ratings of products.
B. Protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged insulation; remove from project site.

1.08 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 15060 – Hangers and Supports.
B. Coordinate clearance requirements with piping Installer for insulation application.
C. Coordinate installation and testing of steam or electric heat tracing.

1.09 SCHEDULING

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.01 PIPE INSULATION MATERIALS

A. Fiberglass Pipe Insulation: FS HH-I-558, Form D, Type III, Class as indicated.

1. Provide Class 12 for piping where highest temperature does not exceed 450° F.

B. Fiberglass Pipe Fitting Insulation: FS HH-I-558, Form E, Class as indicated.

1. Provide Class 16 for use with Class 12 fiberglass pipe insulation, where temperature does not exceed 450° F.

C. Cellular Glass Pipe Insulation: FS HH-I-1751 / 3A, Type I, Class 4.

D. Calcium Silicate Pipe Insulation: FS HH-I-1751 / 5, Type I, factory-applied jacket, Class III.

E. Flexible Unicellular Pipe Insulation: FS HH-I-573, Class as indicated

F. Vapor Barrier Material: FS HH-B-100, Type I, paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing.

G. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for application indicated.

H. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.02 DUCTWORK INSULATION MATERIALS

A. Rigid Fiberglass Ductwork Insulation: FS HH-I-558, Form A, Type Rigid, Class as indicated.

1. Provide Class 1 (non-load-bearing) where insulation is not subjected to compressive loading.
2. Provide Class 2 (load-bearing) where insulation is subjected to compressive loading: except provide higher Class where indicated.

B. Flexible Fiberglass Ductwork Insulation: FS HH-I-558, Form B, Type I, Class as indicated.

1. Provide Class 6 for temperatures up to and including 350º F.

C. Cellular Glass Ductwork Insulation: FS HH-I-551 / 3A, Type I.

D. Flexible Unicellular Sheet Insulation: FS HH-I-573, Class S.

E. Vapor Barrier Material for Ductwork: FS HH-B-100, paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to factory-applied vapor barriers on adjoining ductwork insulation, where available; with following construction characteristics:

1. High Puncture Resistance: Type I, low vapor transmission (for ducts in exposed areas).
2. Moderate Puncture Resistance: Type II, medium vapor transmission (for ducts in concealed areas).

F. Ductwork Insulation Accessories: Provide staples, bands, wires, tapes, anchors, corner angles and similar accessories as recommended by insulation manufacturer for application indicated.

G. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.03 EQUIPMENT INSULATION MATERIALS

A. Rigid Fiberglass Equipment Insulation: FS HH-I-558, Form A, Class as indicated.

1. Provide Class 1 (non-load-bearing) for temperatures up to and including 400ºF and where insulation is not subjected to compressive loading.

2. Provide Class 2 (load-bearing) for temperatures up to and including 400ºF and where insulation is subjected to compressive loading.

B. Flexible Fiberglass Equipment Insulation: FS HH-I-558, Form B, Type I, Class as indicated.

C. Wire-Faced Fiberglass Equipment Insulation: FS HH-I-558, Form C, Class as indicated.

D. Cellular Glass Equipment Insulation: FS HH-I-551, Type I.

E. Flexible Unicellular Equipment Insulation: FS HH-I-573, Class S.

F. Jacket Material for Equipment Insulation:

1. Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, except as otherwise indicated.

G. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

H. Equipment Insulation Accessories: Provide staples, bands, wires, wire netting, tapes, corner angles anchors, stud pins and metal covers as recommended by insulation manufacturer for application indicated.

PART 3 EXECUTION

3.01 PLUMBING PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on exposed plumbing fixture runouts from face of wall or floor to fixture; on unions, flanges, strainers, flexible connections and expansion joints.

B. Cold Piping:

1. Application Requirements: Insulate the fowling cold plumbing piping systems:

   a. Domestic cold water piping
   b. Interior above ground storm water piping
   c. Plumbing vents within 6 lineal feet of roof outlet

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

   a. Insulation: Fiberglass; 1" thickness
   b. Insulation: cellular glass; 1 1/2" thickness
   c. Insulation: Flexible unicellular; ½" thickness

C. Hot Piping:

1. Application Requirement: Insulate the following hot plumbing piping systems:

   a. Domestic hot water piping.
   b. Domestic hot water recirculating piping

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

   a. Insulation: Fiberglass; 1" thickness
   b. Insulation: cellular glass; 1 1/2" thickness
   c. Insulation: Flexible unicellular; ½" thickness

3.02 HVAC PIPING SYSTEM INSULATION

A. Insulation Omitted: omit insulation on hot piping within radiation enclosures and fan-coil unit cabinets; on cold piping within fan-coil unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.

B. Cold Piping (40° F to ambient):

1. Application Requirements: Insulate the following cold HVAC piping systems:
   a. HVAC chilled water supply and return piping
   b. HVAC make-up water piping

2. Insulate each piping system specified above with one of the following types and thickness of insulation:
   a. Insulation: Fiberglass; 1" thick for pipe sizes up to and including 4", 1 ½" thick for pipe sizes over 4".
   b. Insulation: Cellular glass; 1 ½" for pipe sizes up to and including 4", 2" thick for pipe sizes over 4".
   c. Insulation: Flexible unicellular; ½" thick for pipe sizes up to 1 ½" (largest size permitted).

C. Dual Temperature Piping (40°F to 250°F):

1. Application Requirements: Insulate the following dual temperature HVAC piping systems:

   a. HVAC hot / chilled water supply and return piping

2. Insulate each piping system specified above with one of the fowling types and thickness of insulation:

   a. Insulation: Fiberglass; 1" thick for pipe sizes up to and including 4", 1 ½" thick for pipe sizes over 4".
   b. Insulation: Cellular glass; 1 ½" for pipe sizes up to and including 4", 2" thick for pipe sizes over 4".

D. Hot Low Pressure Piping (to 250°F)

1. Application Requirements: Insulate the following hot low pressure HVAC piping systems (steam piping up to 15 psi, water piping up to 250°F.

a. HVAC hot water supply and return piping
b. Low pressure steam and condensate piping

2. Insulate each piping system specified above with one of the following types of thickness of insulation:

a. Insulation: Fiberglass: 1" thick for pipe sizes up to and including 1", 1 ½" thick for pipe sizes 1 ¼" through 4", 2" thick for pipe sizes 5" and over. Provide Class 13 for superheated steam above 450°F (232°C).

3.03 DUCTWORK SYSTEM INSULATION

A. Cold Ductwork (below ambient temperature):

1. Application Requirements: Insulate the following cold ductwork:

a. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.

b. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet.

c. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet: except omit insulation on return ductwork located in return air ceiling plenums.

d. HVAC plenums and unit housings not pre-insulated at factory.

2. Insulate each ductwork system specified above with one of the following types of thickness of insulation:

a. Insulation Rigid fiberglass 1 ½" thick, increase thickness to 2" in machine, fan, and equipment room.

b. Insulation: Flexible fiberglass; 1 ½" thick, application limited to concealed locations.

B. Dual Temperature Ductwork:

1. Application requirements: Insulate the following dual temperature Ductwork:

   a. Hot / cold supply and return ductwork between fan discharge, or HVAC unit discharge, and room terminal outlets; except omit insulation on return air ductwork located in return air ceiling plenums.

2. Insulate each ductwork system specified above with one of the Following types and thicknesses of insulation:

   a. Insulation; Rigid fiberglass; 2" thick
   b. Insulation; Flexible fiberglass; 2" thick, application limited to concealed locations.

3.04 EQUIPMENT INSULATION

A. Cold Equipment (below ambient temperature):

1. Application requirements: Insulate the following cold equipment:

   a. Refrigeration equipment, including chillers, tanks and pumps
   b. Drip pans under chilled equipment
   c. Cold and chilled water pumps
   d. Funnel drains including traps and check valves connected to storm water piping system

2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

   a. Insulation: Fiberglass; 2" thick for cold surfaces and 3" thick for chilled surfaces.

   b. Insulation: Flexible unicellular; 1" thick for cold and chilled surfaces.

B. Hot Equipment (above ambient temperature):

1. Application Requirements: Insulate the following hot equipment:

    a. Hot water generators
    b. Heat exchangers
    c. Condensate receivers
    d. Hot water expansion tanks
    e. Hot water pumps
    f. Condensate pumps
    g. Boiler breeching and stack

2. Insulate each item of equipment specified above with one of the Following types and thick nesses of insulation:

    a. Insulation: Fiberglass; 2" thick for hot surfaces, except 3" thick for steam-jacketed heat exchangers.
    b. Insulation: Calcium Silicate; 3" thick for hot surfaces, except 4 ½" thick for steam jacketed heat exchangers.

3.05 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacture's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to testing and acceptance of test.

C. Install insulation materials with smooth even surfaces. Insulate each continuous run of piping with full length units of insulation, with simple single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at installers option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.

I. Pipe Hanger Insulation Inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.06 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with manufacture's written instructions, and in accordance with recognized industry practices to ensure that insulation serves it's extended purpose.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

E. Extend ductwork insulation without interruption through wall floors and similar ductwork penetrations, except where otherwise indicated.

F. Lined ductwork: except where otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

G. Corner angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation and ductwork in exposed finished spaces before covering with jacketing.

3.07 INSTALLATION OF EQUIPMENT INSULATION

A. General: Install equipment thermal insulation products in accordance with manufacture's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler from gapping joints and excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

D. Do not apply insulation on hot equipment.

E. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulating cement, toweled in workman like manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover insulated surfaces with glass cloth jacketing neatly fitted and firmly secured. Lap seams at least two inches. Apply over vapor barrier where applicable.

H. Do not insulate handholes, cleanouts, **ASME** stamp, and manufacture's nameplate. Provide neatly beveled edge at interruptions of insulation.

I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

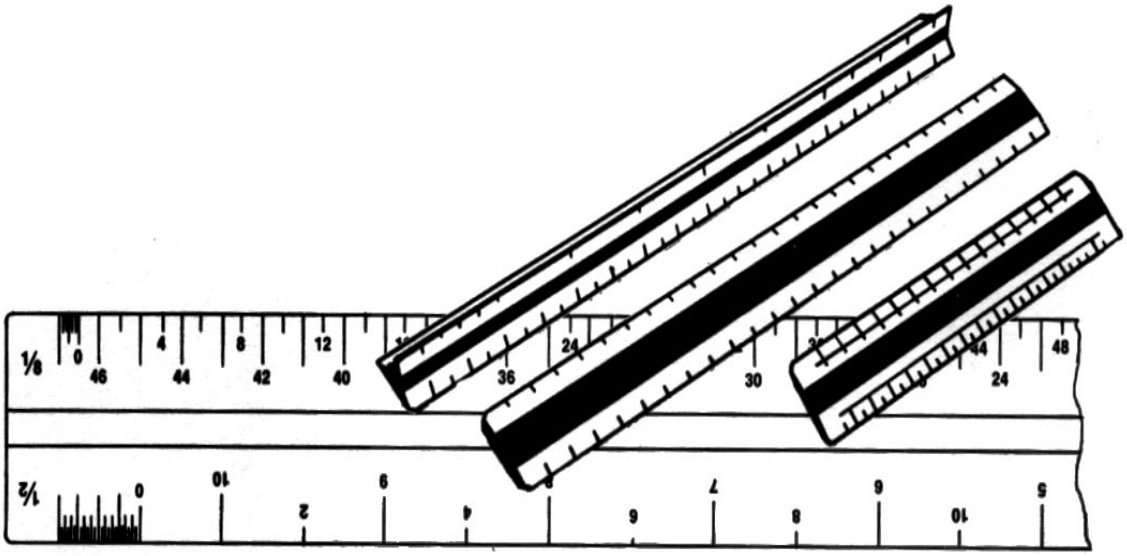
3.08 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period to avid damage and deterioration.

END OF SECTION 15250

UNIT 4
SCALING

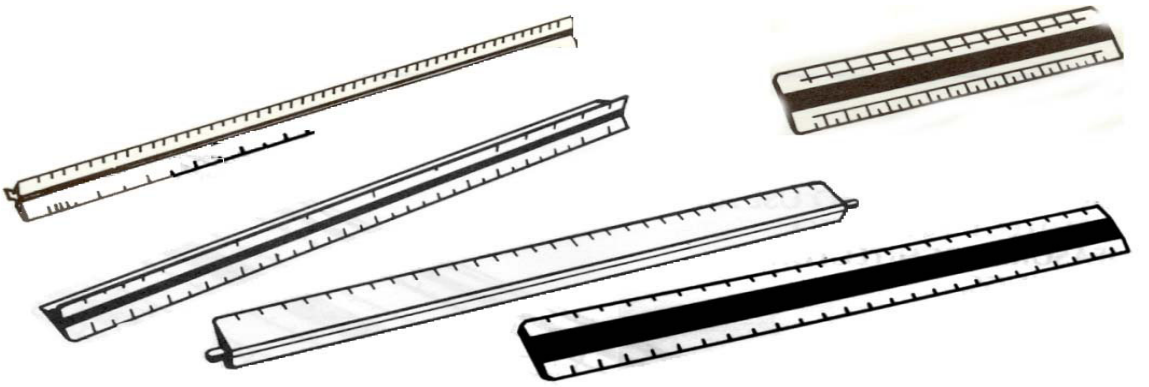
WHEN YOU COMPLETE THIS UNIT YOU WILL BE ABLE TO USE AN ARCHITECT'S SCALE TO MEASURE ARCHITECTURAL DRAWINGS.



INTRODUCTION

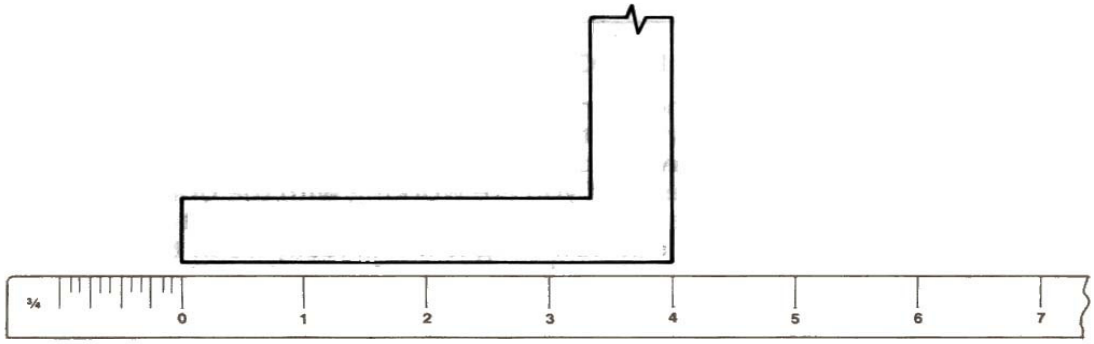
Like everyone who works with the set of drawings, the insulator must know how to use an architect's scale. Architectural drawings have to be reduced in size so that they fit on the sheets. However, if you are working with the drawings, you often have to measure a piece of pipe or duct on the drawing to find out how long it will be in the building. The architect's scale is a special ruler that allows you to measure an object on the drawing and know immediately how long the actual object will be.

In this unit you will find that the word **scale** is used in different ways:
Drawing **to scale** means drawing an object smaller (usually) than the actual size, keeping all dimensions in exact proportion.
A **scale** is the particular proportion chosen when making a drawing to scale. For example, a drawing could use the scale **1"= 1'-0".**
An architect's **scale** is a special ruler used to draw or measure architectural drawings "to scale"
.A drafter **scales** a drawing by drawing it to scale.
An insulator **scales** an object on a drawing by measuring it with an architect's scale to see how long the actual object is.



COURTESY CHARTPAK

1: Different architect's scales



¾" scale measures 4'-0" duct

The words are all related, and you should have no problem knowing which is which once you understand the subject.

Obviously, the set of drawings for a building cannot be made full size. But a drawing has to be made exactly in proportion to the real thing. So whoever makes the drawing has to decide how much the planned building has to be **scaled down**. For example, the drafter may decide that one inch on the drawing will equal one foot on the building. Therefore a piece of pipe in the building that is two feet long will be two inches long on the drawing.

Some of the dimensions (how long something is) will be marked on a drawing. But it isn't practical to label the dimensions of everything on the drawings. Therefore, anyone who works with the drawings must be able to figure out the dimensions by measuring directly from the drawing.

In order to measure anything on the drawing, whoever works with the drawing has to know what scale the drafter used. If the drafter used one inch on the drawing to mean one foot on the building, the insulator can measure three inches of pipe on the drawing and know that it represents three feet of pipe in the actual building.

However, it may not be convenient to use one inch to represent one foot. Perhaps **½" or ⅜" to a foot** would produce a drawing of a convenient size. How would you measure something on a drawing if it where drawn to a scale of **⅜" to a foot**? You could probably figure out how to do it, but it would take time and could produce **errors**, which you, the contractor and the union can not afford!!

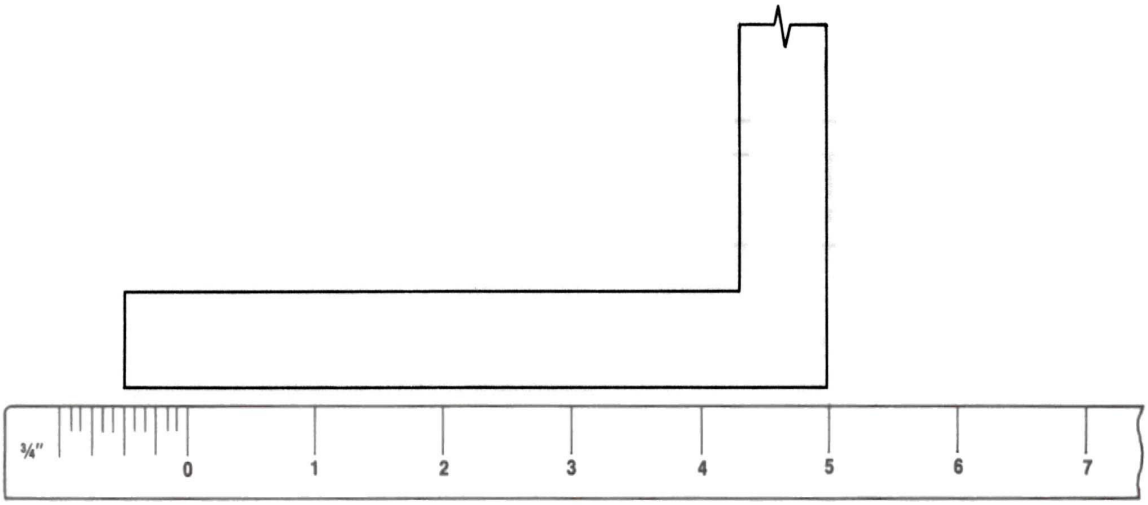


Fig. 3: ¾" scale measures 5'-6" duct

THE ARCHITECT'S SCALE

To make the process easy, an **architect's scale** (Fig.1) is used. This is a type of ruler for measuring drawings that have been reduced to a convenient size. It converts inches to feet so that a scaled drawing can be measured directly. For example, suppose a drawing has been made with a scale of **¾" equals one foot**. A ¾" scale (Fig.2) would have intervals marked that are actually ¾" apart. Each interval represents one foot. In Fig.2, the ¾" scale is being used to measure the drawing of a length of duct. As shown on the scale, the duct is four feet long.

The very small intervals or increments on the left end of the scale (**before 0**) are used to measure inches. Figure3 shows how another piece of duct is being measured. It is five full feet long (as measured by the numbers on **the right**) plus six inches (measured by the inch markings on **the left**). The piece of duct is 5'-6" long.

Having a ¾" scale rule to work with makes **drawing** much easier for the drafter. The scale also makes **measuring the drawing** much easier for the insulator.

Many different scales may be needed to make all the drawings in a set of plans. A **triangular** architect's scale combines many different scales in one device. It allows you to measure with a standard ruler and also with all of these scales:

3/32" = 1'-0" 3/16" = 1'-0" ⅛" = 1'-0" ¼" = 1'-0" ⅜" = 1'-0"

½" = 1'-0" ¾" = 1'-0" 1" = 1'-0" 11/2" = 1'-0" 3" = 1'-0"

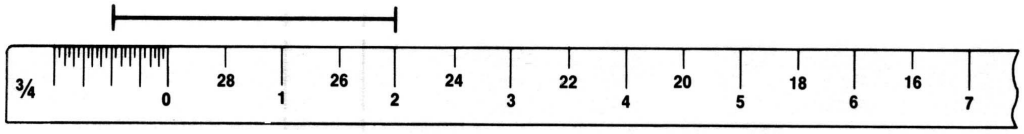


Fig. 4: ¾" Scale on an architect's scale measuring a 2'-6" line

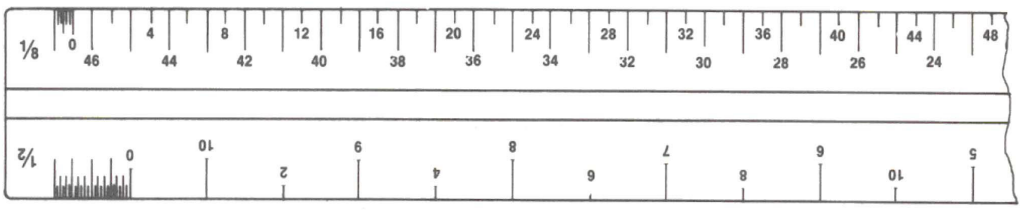


Fig. 5: ⅛" scale on an architect's scale

In order to get all these scales on one device, two different scales are marked on each edge of the scale. Some are read from **left to right** and some are read from **right to left.** This makes it confusing to us at first, but with some practice, you will find it easy to use. Remember that the **numbers indicate feet**.

Start by finding the ¾" scale on an architect's scale (Fig.4). This looks like the scale in Fig.2 and 3, except that there are other numbers between the 1,2,3,4, etc. These extra numbers belong to the ⅜" scale which begins on the right. If you want to use the ¾" scale , use the numbers that begin on the left with **0**. **Ignore** the other numbers.

To measure an object with the ¾" scale, follow the two steps below:

1. Place the scale so that the largest number of full feet can be measured on the object.
2. Find the number of inches beyond zero that can be measured on the object.

For example, the scale in Fig.4 is measuring a line that is 2'-6". It is measured following the two steps just described:

1. The **right end** of the line reaches the 2 on the scale, so the line is at least 2 feet long.
2. The **left end** of the line reaches the **middle** of the section divided into inches, so the line has an additional 6 inches.

The other scales are used in the same way. For example, find the ⅛" scale (Fig.5) on an architect's scale and use the numbers that begin with 0. **Ignore** the numbers (46, 44, 42, etc.) that belong to the ¼" scale that begins on the other end of the rule.

PRACTICE PROBLEMS

Measure each of the lines below using the ¾" scale of an architects scale:

1. 

_____

2. 

_____

3. 

_____

Measure each of the lines below on the ⅛" scale of an architect's scale:

4. 

_____

5. 

_____

6. 

_____

Reading Scales from the Right

Some of the scales are read from the right to left. For example, find the scale for **¼"** (Fig.6) which reads from the right to the left. When using the ¼" scale, use only the numbers that start with **0** on the **right**. **Ignore** the other numbers, which belong to the ⅛" scale.

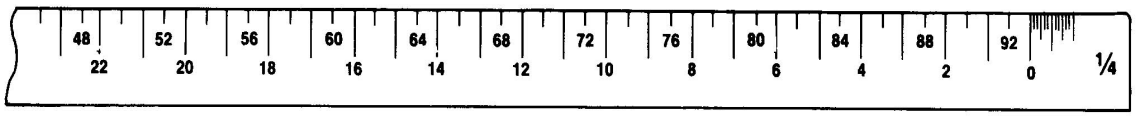


Fig. 6: ¼" scale on an architect's scale

PRACTICE PROBLEMS

Measure each of the lines below with the ¼" scale

7. 

_____

8. 

_____

9. 

_____

Measure each of the lines below with the ½" scale:

10. 

_____

11. 

_____

12. 

_____

Insert your own scaling problems according to your local needs on your own drawings.

SCALING ON A SET OF DRAWINGS

When you do measure a drawing with an architect's scale, do not expect measurements to be absolutely accurate. Paper can shrink slightly, and this can change measurements. If a drawing is reproduced, it may be reduced or enlarged slightly by the process. Sometimes a drafter can make a small **error in dimensions** while drawing.

Therefore, a scaled line may not be absolutely accurate to a fraction of an inch. However, scaling a dimension is accurate enough to provide the information you need for planning and estimating.

When you use a scale to measure on set of drawings, the first step is to find out what scale to use. The drafter who makes the drawing will indicate the scale on the drawing. Before you measure, always be sure to find the **note that tells what scale** the drafter used.

If **no scale** is shown, the drawing may **not** be drawn to scale. These drawings are usually marked **(NTS.)** NOT TO SCALE**.** If this is so, dimensions cannot be determined by scaling. If a drawing seems to be drawn to scale but no scale is indicated**, find** some dimension lines that specify a particular dimension. Use the architect's scale to see which scale **fits** the dimensions that are given. **Check several** of the dimensions to be sure the drawing is actually to scale.

Another way to determine measurements on a drawing or to check the scale being used, is by using the given measurements from the bay lines usually shown on a plan view. On the example below we see the distance given between **bays** like **B - C or D - E** is **24' (ft) except between A – B** which is a double bay where the distance therefore is at 48'(ft).Now if we have lines running the length of the building we can calculate the measurements with great ease and almost instantaneous by calculating the bays.

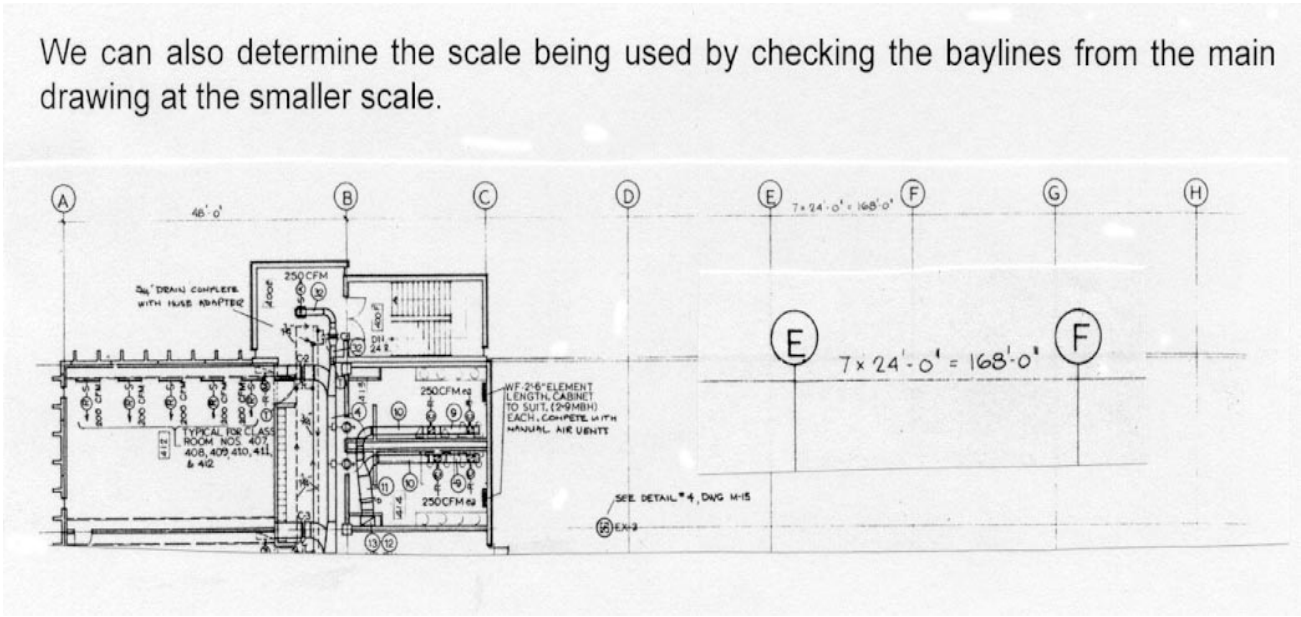


Figure 6 – b: Bay Lines

SCALING TERMS

As you have noticed by now, a scale is identified by a note like this:

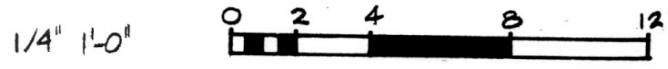
½" = 1'-0"

The number on the **left** (1/2") gives the measurement on the **drawing**. The number on the **right** (1'-0") gives the measurement on the object.
A particular scale can be referred to as a 3/8" scale, a ½ " scale, or the like.

Full scale (or full size) means that nothing is reduced. A full scale drawing can be measured with an ordinary ruler. On an architect's scale, the ruler for measuring full scale drawings is marked 16.

Half scale (or half size) means that 6" on the drawing equals one foot. (This is very different from the ½" scale which means that ½" on the drawing equals one foot.) The term half scale is also used to refer to drawings that are **reduced in size**. These are described in the next section of this unit.

Quarter scale (or quarter size) means that that 3" on the drawing equals one foot, (This is very different from the ¼" scale which means that ¼" equals one foot.)



IF DRAWING IS A REDUCTION, USE GRAPHIC SCALE.

7 Graphic scale

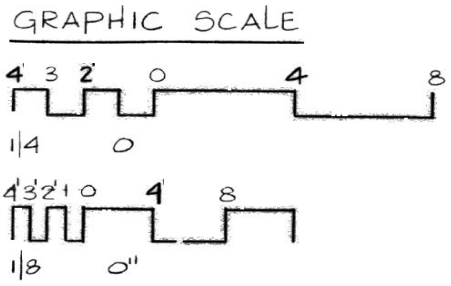


Fig 8: Graphic scale

REDUCED DRAWINGS

The sheets of a set of plans may be very large. They are expensive to copy and difficult to handle. Therefore, the sheets are sometimes reduced to a smaller size.

If the sheets are reduced, they are usually reduced so that a line that is four inches long on the original drawing is only two inches long on the copy. This kind of reduction is called **half scale**. The whole sheet will be half as long as the original and half as high. This means the sheet will be a quarter of the size of the original, although every line on the drawing is half the length of the original.

To prevent confusion if a drawing is reduced, a **graphic scale** is added to the drawing. This is a kind of ruler that shows you exactly how long a line is, that represents one foot. Two different styles of graphic scales are shown in Fig.7 and Fig.8. If a drawing is reduced, use a graphic scale to find out which scale on the architect's scale to use. Find the scale where a one foot measurement is the same as the one foot measurement on the graphic scale.

OTHER SCALES

There are other types of scales used for various purposes. Be sure you use an architect's scale on architectural drawings. Other scales may give readings in **decimals** of a foot or in **metric** measurements. Some other types of scales include the following:

Engineer's scale (also called a civil engineer's scale or chain scale)
Mechanical engineer's scale (also called a mechanical draftsman's scale)
Decimal scale
Metric scale

The information in this unit covers only the architect's scale.

REVIEW PROBLEMS

Completion (Fill in the blank)

1. Full scale means that 6" on the drawing equals _____ on the object.

2. Half scale means that 6" on the drawing equals _____ on the object.

3. Quarter scale means that 6" on the drawing equals _____ on the object.

4. ½" scale means that ½" on the drawing equals _____ on the object.

5. 3/8" scale means that _____ on the drawing equals one foot on the object.

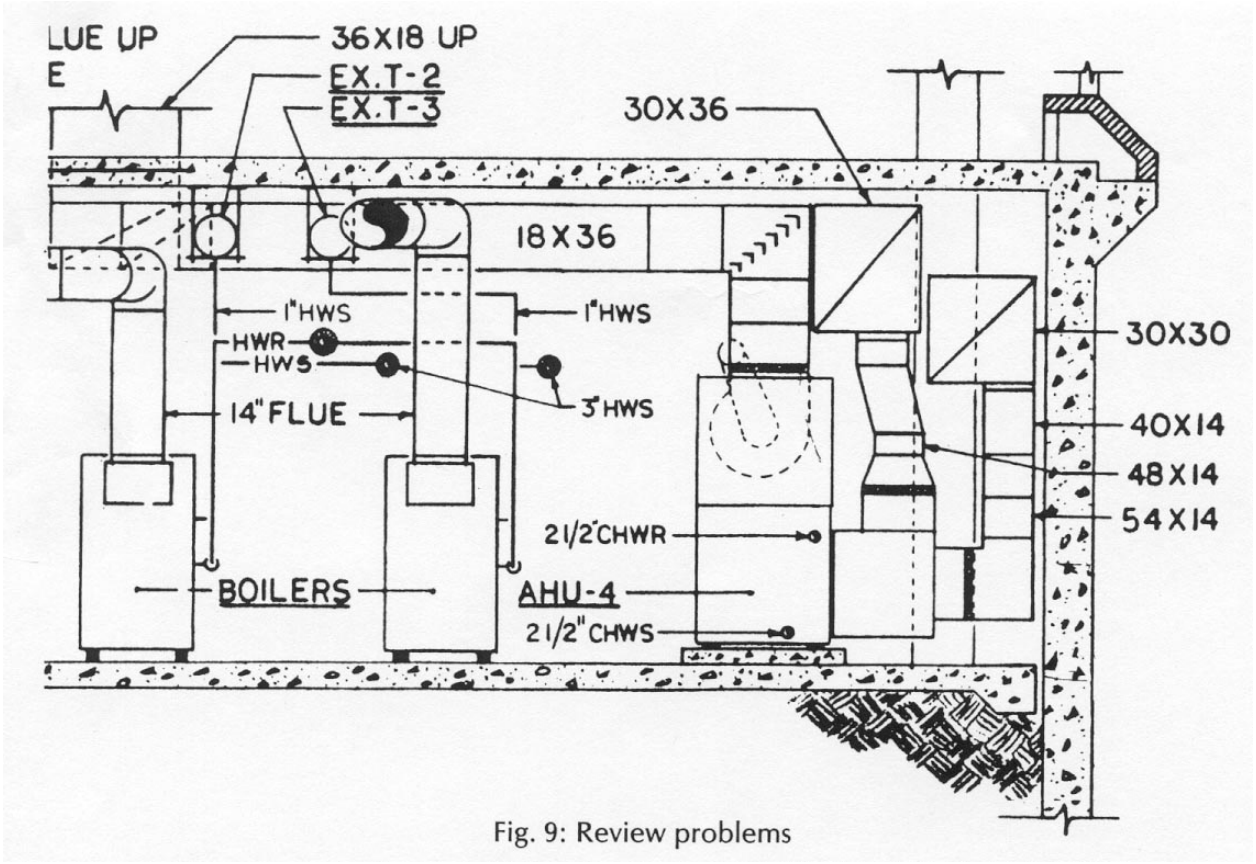


Fig. 9: Review problems

The section drawing in Fig.9 (above) is drawn to a scale of **¼" = 1'-0".** Use an architect's scale to find the dimensions of the items listed below.

1. Thickness of the concrete wall

   _____

2. Height of the room (floor to ceiling)

   _____

3. Distance from floor to top of the boilers

   _____

4. Width of air handling unit (AHU-4)

   _____

It is a tremendous help to us to be good at scaling when running a project, as an example when ordering material or checking our stock on site. At a glance we see the pipe or duct run the length of the building or the height of the risers between floors. Also quite often your boss will ask you how much more is left to do on a jobsite, or how much additional material is needed to complete the job. These are examples where good scaling is handy. This allows you to give an intelligent answer and avoids a lot of problems for everyone involved.

Answers to Practice Problems for unit 4:

Item numbers 1 to 12

(Pages 44 and 45)

1.= 3’-0”

2.= 2’-6”

3.= 1’-9”

4.= 16’-0”

5.= 10’-6”

6.= 7’-0”

7.= 7’-3”

8.= 9’-9”

9.= 3’-6”

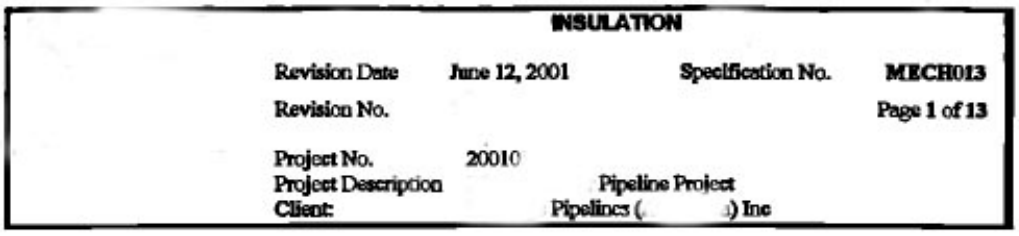
10.= 4’-3”

11.= 5’-0”

12.= 3’-9”

UNIT 25
TYPICAL INDUSTRIAL SPECIFICATIONS

WHEN YOU COMPLETE THIS UNIT
YOU WILL HAVE HAD PRACTICE WORKING WITH
INDUSTRIAL SPECIFICATIONS.



INSULATION

Revision Date	June 12, 2001	Specification No.	MECH013
Revision No.			Page 1 of 13
Project No.	20010		
Project Description	Pipeline Project		
Client:	Pipelines ( ) Inc		

SPECIFICATION FOR

INSULATION

REV	DESCRIPTION	DATE	PREPARED BY UPSIDE	CHECKED BY UPSIDE	APPROVED BY CLIENT
1	General Review	06/12/01	MRF	MRF	
0	Issued for Bid	04/26/01	DLU	MRF	

Typical Industrial Project Insulation Specifications (13 Pages)

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5.0	VESSELS AND TANKS	9
6.0	OTHER EQUIPMENT ITEMS	10
7.0	APPLICATION OF HOT INSULATION	10

1.0 SCOPE

1.1 This specification is designed for insulation requirements on piping, pressure vessels, storage tanks, heat exchangers, pumps, etc., operating in hot services.

1.2 The Contractor shall provide all material, labour transportation, tools, apparatus, and scaffolding required for the proper execution of the work set out in the specifications.

1.3 The Contractor shall perform the insulation work with the highest quality workmanship throughout.

1.4 After the Work covered by this Specification has been completed, all debris resulting from such Work, excess materials, and equipment used, shall be removed and the premises left in a condition satisfactory to the Owner.

1.5 Insulation shall not be installed until all equipment and piping involved has been tested for leakage and made tight. All services which are to be insulated shall be cleaned of all dirt, grease, etc., and shall be perfectly dry before insulation is applied.

1.6 All material must be new and undamaged. It must be protected from the weather for storing and during construction.

2.0 GENERAL REQUIREMENTS FOR HOT INSULATION

Apply insulation on piping and equipment when:

2.1 Insulation is necessary for temperature stabilization (hot insulation).

2.2 Conservation of heat to the operation will be beneficial (hot insulation).

2.3 Bare metal temperatures exceed 70°C (160°F) (personnel protection) and equipment or piping is within operator reach (elevation above floor level less than 2300mm).

3.0 INSULATION THICKNESS

Thickness of insulation shall be in accordance with the following Insulation thickness tables:

TABLE NO. 1

HOT INSULATION PROCESS PIPING
RECOMMENDED THICKNESS, MILLIMETERS

Pipe Size (millimeters)	Operating Temperature °C 38 to 121	122 to 197	198 to 260	261 to 315	316 to 400
48.3 & under	38	25	25	38	51
60.3	38	25	38	51	51
88.9	38	38	38	51	64
114.3	38	38	51	64	76
168.3	51	51	51	64	76
219.1 & 273.1	51	64	64	76	89
323.9 & over	51	64	76	76	89
406	64				

Combinations of insulating materials may be substituted provided they are fully equal in quality and insulating properties. Such substitutions will be permitted only upon written approval from the engineer.

1 INCH = 25 mm

TABLE NO 2

HOT INSULATION EQUIPMENT
RECOMMENDED THICKNESS, MILLIMETERS

Operating Temperature °C

	38 to 121	122 to 197	198 to 260	261 to 315	361 to 400
Equipment	51	64	76	76	89

TABLE NO 3

INSULATION FOR PERSONNEL PROTECTION
RECOMMENDED THICKNESS, MILLIMETERS

Operating Temperature °C

Pipe Size (millimeters)	38 to 197	197 to 400
48 & less	25	38
60.3	25	51
88.9	25	51
114.3	25	51
168.3	25	51
219.1 & 273.1	38	51
323.9 & over	38	511

1 INCH = 25 mm

4.0 INSULATION MATERIALS

No Asbestos bearing material will be allowed.

Specifications and Standards

ASTM Standards

- C 411 Hot-Surface Performance of High Temperature Thermal Insulation.
- E 84 Surface Burning Characteristics of Building Materials.
- A 167 Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip.
- B 209 Aluminum-Alloy Sheet and Plate.
- C 533 Calcium Silicate Block and Pipe Thermal Insulation.
- C 795 Wicking type insulation for use over austenitic stainless steel.

The recommendations of the paint, insulation and vapor barrier manufacturers shall be followed in addition to the requirements of this specification. All conflicts shall be submitted for approval by Owner's authorized representative.

Insulation for equipment and piping subject to stress corrosion such as austenitic stainless steels, shall contain a minimum of 20 ppm (20 mg/kg) sodium silicate for each (1) ppm (mg/kg) of leachable chloride contained in the insulation material. Insulation containing more than 600 ppm (600 mg/kg) chloride is not acceptable for use on this type equipment.

In the following specification, wherever specific materials are mentioned, the intent is to allow substitution of equivalent materials whenever approved by Owner's authorized representative.

4.1.1 Piping Insulation

201°C to 650°C: Premoled Insulation-Calcium Silicate-ASTM C533
-40°C to 200°C: Pre-molded Insulation-Fibreglass.

Note: Buried Pipe

-40°C to 299°C: Urethane Foam with polyethylene outer sheath. (Heat tracing system to be inserted through channel provided during manufacture). Shaw Insul - 8 system or equal.

4.1.2 Vessel Insulation

Same material requirements as pipe. Premolded or block insulation.

NOTE: Due to the low compressive strength of Fibreglass this type of insulation should only be used in an application of less abusive nature.

4.1.3 Cements and Coatings - Hot Service

Finish Cement	Superkote (fibrex)
Insulating Cement	FBX 1900 (fibrex)
Weatherproofing	100-14 Flintguard

4.1.4 Metal Jackets

a) Vessel - 0.6 mm thick flat aluminum sheet (Horizontal) 0.6 mm thick Corrugated (1-1/4" x 1/4") (Vertical)

b) Piping - 0.4 mm flat aluminum sheet

c) Vapour Barrier - all jacketing shall be protected with a vapour barrier.

4.1.5 Jacketing

Jacketing shall be secure with screws on approximately 15 cm centres (the screws shall be used on the longitudinal seams only), and stainless steel bands spaced at centre and at lap, machine stretched and sealed under tension. A band is to be placed adjacent to the heads of horizontal tanks and at top of the top sheet on vertical vessels to secure flashing between head and shell jackets.

All openings to the metal jackets at nozzles, manholes, brackets, etc., are to be cut as close as possible to provide a snug fit and shall be thoroughly sealed to prevent moisture from entering behind the aluminum jacket with GE 1200 silicone or Dow Corning #999 silicone sealant.

4.1.6 Bands-Piping and Vessels

900 mm O.D. or less	- 0.5 mm x 12.7 stainless steel
larger than 900 mm O.D.	- 0.5 mm x 19.0 stainless steel

4.1.7 Miscellaneous Materials

a)	Wire	16 and 18 ga. monel or stainless steel
b)	Wire Mesh	25 mm Hex mesh of No. 20 ga. galv. wire
c)	Screws	No. 8 x 12.7 mm Alum. Hex Head
d)	Glass Fabric	Glasfab. open weave.
e)	Vapour Barrier	6 mil polyethylene (where required)

4.2 Re-usable Blanket Insulation

4.2.1 Liner

Inner lining material shall be teflon coated fiberglass for all devices with a maximum upset temperature of 500°F or below. Where the maximum temperature exceeds 500°F, up to 1000°F, a dual liner of stainless steel mesh and 4 ply laminated aluminum/fiberglass shall be used. The laminated liner shall extend back over the cover to avoid heat damage to the cover.

4.2.2 Insulation Thickness and Material

Insulation thickness shall be 1" for all devices operating at 500°F, up to 1000°F, 2" thick material shall be used as the insulating medium, the density shall be 15 oz/ft. ^{2}/°F at 100°F.

4.2.3 Jacketing Material

Cover material shall be telflon coated fiberglass for all applications.

4.2.4 Construction

Construction features shall include the following for all flexible insulation packs:

a) through cover quilting pins.

b) inside seams and folded closing seams with two parallel rows of stitching.

4.2.5 Fastener/Closure Method

Fastenings shall be suitable for the size and type of cover and shall include the following approved features, individually or in combination:

a) Stainless steel lacing hooks and stainless steel wire.

b) Velcro hooks and loop placket.

c) Cinch belts and fasteners.

4.2.6 Options

Wind flaps at all required cover openings.

All flexible re-usable covers for tagged instruments are to clearly carry the instrument tag numbers on integral stainless steel tags.

Low point drain grommet (stainless steel, required in liquid service only).

4.2.7 Insulated In-line Piping Components

Pipe insulation is to be cut back to allow for stud removal. A flexible re-usable cover is to cover the valve body and the uninsulated pipe.

5.0 VESSELS AND TANKS

5.1 Hot Service

5.1.1 Vessel skirts, saddle supports, flanged connections, need not be insulated.

5.1.2 Nameplates, code stamp plates, shall not be covered.

5.1.3 Manway covers less than 2 m above grade or platform shall be insulated with re-usable blanket insulation.

5.1.4 Expansion clips shall be provided on banding of insulation on large diameter vessels. (Number of expansion springs to be dependent or equipment diameter, minimum ambient tenative and normal operating temperature of equipment to be submitted for approval.

5.1.5 Expansion joints in the insulation are to be provided under each insulation support ring. A 25 mm space between the top of the insulation block and the underside of the support ring shall be tightly packed with mineral wool insulation.

6.0 OTHER EQUIPMENT ITEMS

6.1 Heat exchangers in hot service shall be insulated. This does not apply to those operating at or near ambient temperatures.

6.2 The area to be insulated shall include the exchanger flanges, channel and cover. These covers shall be re-usable blanket insulation, watertight and removable without damage to adjacent shell insulation.

7.0 APPLICATION OF HOT INSULATION

7.1 Piping

Molded sectional insulation shall be applied in broken joint construction and secured with 16 ga. wire loops spaced on 23 cm centres. On double layer construction, lap all joints one-half of each section between layers. Each layer shall be wired separately. Joints shall

be securely butted and all cracks, joints, etc. shall be filled with insulating cement and painted.

Insulation shall be jacketed with aluminum sheet c/w vapour barrier caulking, rolled and cut to fit curvature of insulation. A minimum lap of 50 mm on longitudinal and end joints shall be provided. The jacket shall be secured with screws on 150 mm centres.

7.2 Fittings

Pre-formed or mitered fittings shall be used.

7.3 Manual Valves, Flanges, Unions, Control Valves and Relief Valves

Flanges and valves shall be insulated with removable blanket type insulation to a thickness equal to that on adjacent pipe.

7.4 Terminal Bevels

All pipe covering shall be bevelled back on an approximately 45° angle. A skim coat of insulation cement shall be applied, followed by a 6 mm wet coat of weatherproofing. Weatherproofing shall be extend under the sheet metal jacket. High temperature mastic shall be applied at point where weatherproofing comes in connect with bare pipe. Metal covers are also acceptable.

7.5 Insulation over Tracing

Lines that are traced shall be insulated with large O.D. pipe insulation covering line and tracer and finished in the same manner as straight pipe.

7.6 Equipment

7.6.1 Shells

To the clean surface of the vessel, block insulation shall be cut to fit vessel shell, secured with bands, machine stretched, and fastened. All cracks or voids shall be painted with insulation cement. Over the block insulation a vapour barrier shall be applied. Over vapour barrier a sheet metal jacket aluminum sheet and caulking shall be applied. Each course of metal sheets shall be supported with metal bands as specified under jacketing. All sheets shall be lapped at least 7.5 cm on vertical seams and secured with sheet metal screws. All circumferential seams shall be lapped at least 7.5 cm. Sheet metal screws shall be omitted at circumferential seams to allow for expansion.

7.6.2 Heads

Block insulation shall be applied in the same manner as shell and secured with bands. All cizacks and voids shall be pointed with insulating cement.

An aluminum "orange peel" cover shall be applied over the banded insulation.

7.6.3 Horizontal Vessels and Exchangers

Shall be insulated in the same manner as vertical vessels for shell and heads. All seams shall be lapped at least 7.5 cm and secured with sheet metal screws and banding as specified under jacketing.

7.6.4 Plate Exchangers are to be enclosed by a space- frame and insulated with a 2" thick re-usable blanket insulation.

7.6.5 Pumps are to be insulated with a 2" thick re-usable blanket insulation.

7.6.6 Closures on strainers and scraper barrels, as well as other such equipment requiring frequent access for operation and maintenance shall be insulated with 2" thick re-usable blanket insulation.

The above Specs. are copies of actual field specifications from a Natural Gas and Pipeline Project. They are a good example of the type of work we encounter when we are working at an Industrial work site.

Remember accuracy in reading the specifications is an absolute must if we want to have a future in the Industry !!!