## G2 Gas Technician Module 22 Revised Questions and Answers with complete solution

What pressure does atmospheric pressure exert on the earth at sea level? Ans- 14.74 psia

What two things mean you must bring in combustion air. Ans- 1. Total BTU of appliance if greater than 400000 you must bring in combustion air.
2. If house is tight construction you also must bring in air.

What is the maximum flue gases should be for a natural draft system? Why? Ans- 450 F is the max this is because safety concerns of having high heat in a combustible building and the hotter the gasses the more inefficient the system is.

What is the minimum flue gas temperature should be? Why? Ans- Greater then 127 F, this is when the flue gases will condense causing corrosion due to its highly acidic nature

What do special venting systems do? Ans- They are used with high efficient or condensing furnaces. They condense the flue gases to release more heat back into the building. Latent heat of 1 lb of water vapor converting to liquid will release 970 btu back into the structure.

What does direct venting do? Ans- Supplies combustion air directly from the outside and expels flue gases directly to the outside.

What is an example of a positive vent pressure system? Non - positive system? Ans- Positive - Hi eff. furnace
Non positive - natural draft

What does flue loss determine? Ans- If the appliance is a condensing system.

What is a type A vent? Ans- They are chimneys made of masonry or steel

What are B vents? Ans- Are double walled vents that can run through a ceiling to the outside

What are Type L vents? Where are they used? What is max flue temp? Ans- 1. They are double walled insulated vents with interior wall constructed of stainless steel
2. They are used when heat/corrosion could be a problem
3. Must not exceed 550 F

# CSA Unit 6 – Materials, Drawings and Graphs

# Chapter 1
# Reference Materials for Gas Technicians

Gas technicians need access to current reference materials to ensure safety and efficiency in their work with constantly changing gas equipment and piping systems.

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MK by Mike Kapin

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# Overview and Purpose

## Daily Work

Gas technicians/fitters install, service, and maintain gas equipment and piping systems daily.

## Changing Systems

The systems and types of equipment they work on are constantly changing; therefore, having access to current reference material is vital.

## Installation Requirements

Installation and servicing of gas-fired equipment according to codes, regulations, and manufacturer's specifications is a must.

## Chapter Purpose

This Chapter will explain the various reference materials that the gas technician/fitter will encounter and how to use them to ensure safety and efficiency of work.

# Objectives

## Learning Goal

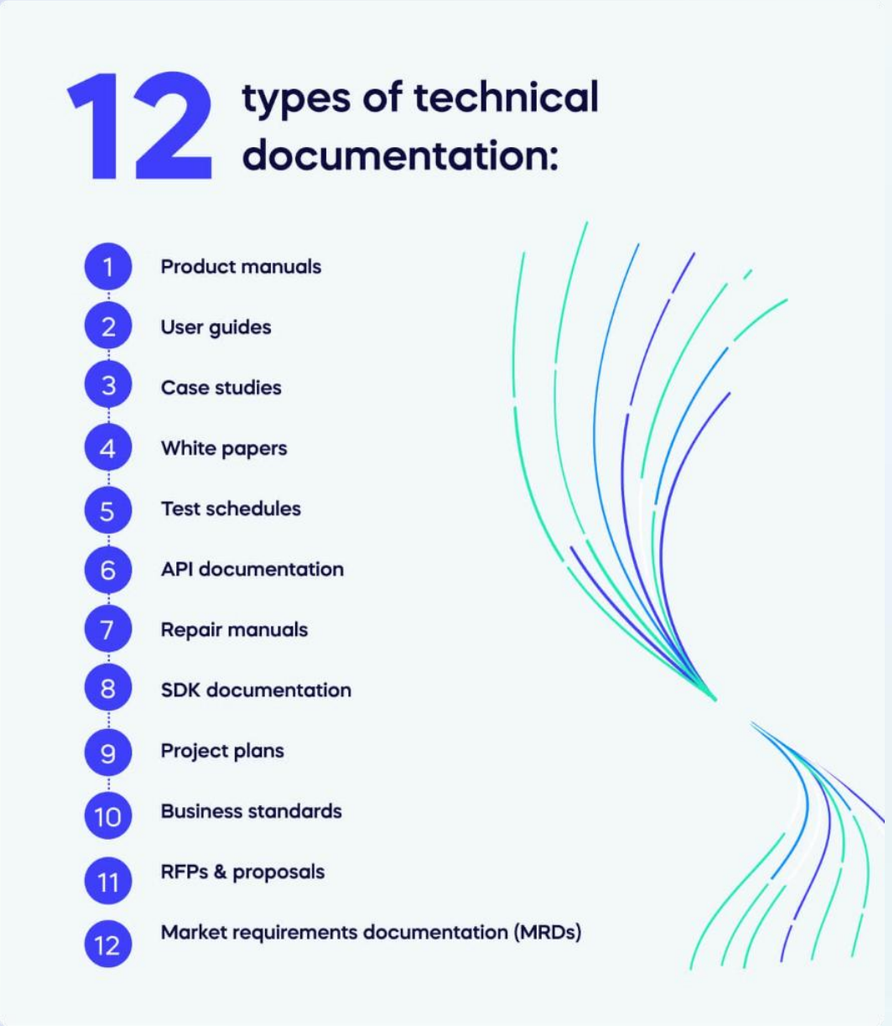
At the end of this Chapter, you will be able to:

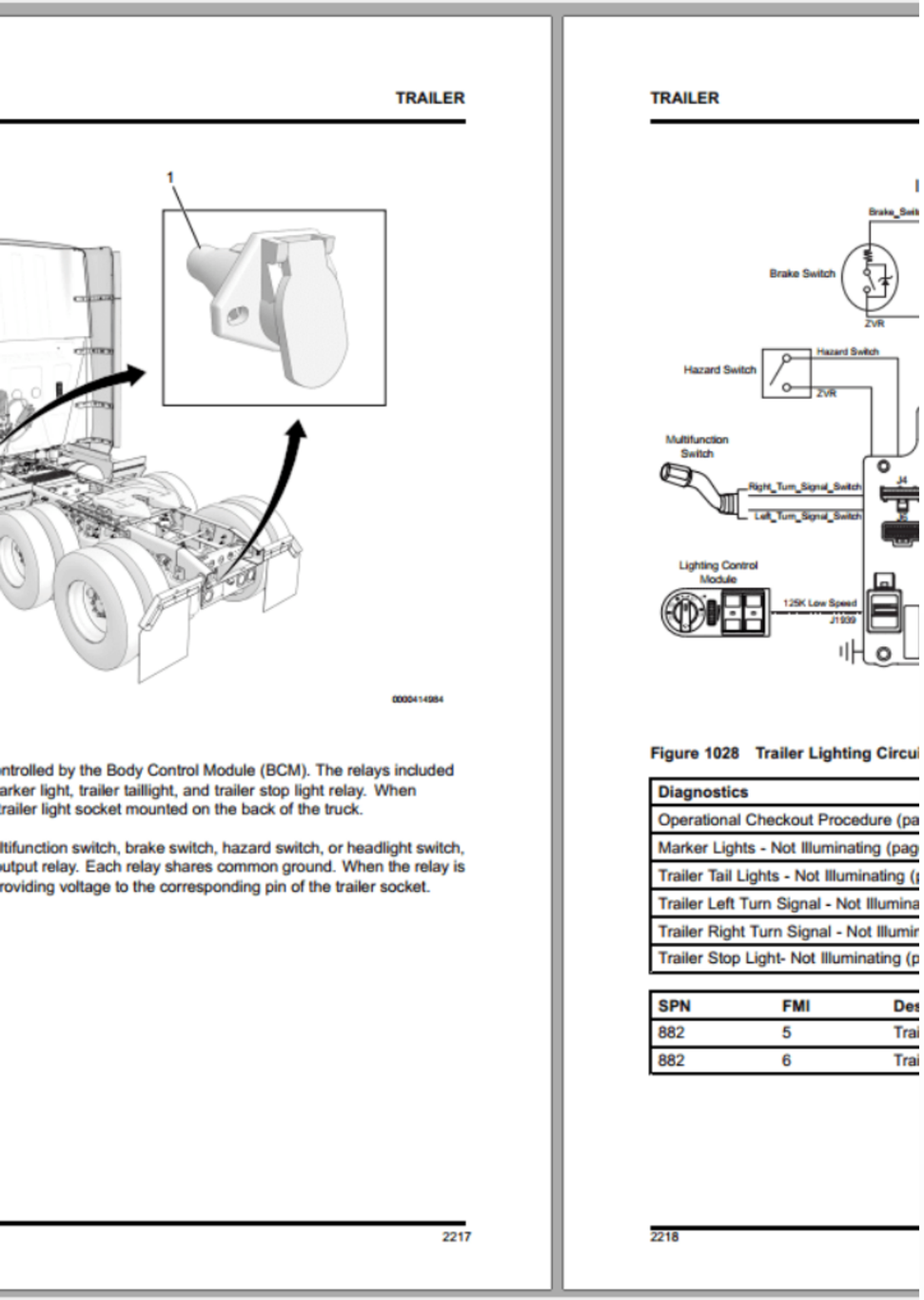
## Information Location

locate specific information in reference materials.

# Terminology

| Term | Abbreviation (symbol) | Definition |
| --- | --- | --- |
| Manufacturer service bulletins | | From a manufacturer, instructions with guidelines for servicing and maintaining the appliance or equipment or updates on equipment problems and provisions for solutions |
| Manufacturer specifications | | From a manufacturer, the specifications and certified installation instructions for its appliances and equipment |






# Types of Reference Materials

## Code Books

Essential reference for installation standards

## Installation Manuals

Detailed instructions for specific equipment

## Government Documents

Acts, regulations, bulletins, and directives

## Manufacturer Resources

Manuals, specifications and service bulletins

A gas technician/fitter will need to reference code books, installation manuals, and government acts, regulations, bulletins, and directives, as well as manufacturer's manuals, specifications and service bulletins.

# CSA Gas Trade Training Materials

| CSA Gas Trade Unit | Title | 2014 Red Seal Block | 2014 Red Seal Task |
|---|---|---|---|
| 1 | Safety | A - Common Occupational Skills | Task 1 Performs safety-related functions. |
| 2 | Fasteners, Tools and Testing Instruments | A - Common Occupational Skills | Task 2 Maintains and uses tools and equipment. |
| 3 | Properties, Characteristics, and Safe Handling of Fuel Gases | A - Common Occupational Skills | Task 3 Plans and prepares for installation, service and maintenance. |
| 4 | Utilization Codes, Acts and Regulations | B - Gas Piping Preparation and Assembly | Tasks 4-6 Fits tube, tubing, plastic pipe, and steel pipe for gas piping systems. |
| 4A | Utilization Codes, Acts, and Regulations Ontario Supplement | C - Supply Systems Venting and Air | Tasks 7-9 Installs venting, air supply system, and draft control systems. |

# Code Books and Manuals

## CSA B149.1 Natural gas and propane installation code

The Natural gas and propane installation code, CSA B149.1, has 10 main sections, as identified in the Code's Table of Contents.

### Finding Information

You can find a topic by either searching the Table of contents by "Clause" titles or by using the key word index at the back of the Code.

#### Preferred Method

The index is the preferred method since it may show cross-references on the topic in various clauses of the Code.

# CSA B149.2 Propane Storage and Handling Code

## Code Structure

The Propane storage and handling code, CSA B149.2, has nine main sections

## Table of Contents

Sections are identified in the Code's Table of contents

## Index Search

Or use the index for more comprehensive search results

## Finding Information

You can locate information by looking in the Table of Contents

# CSA B149.3 Code for Field Approval

## Purpose

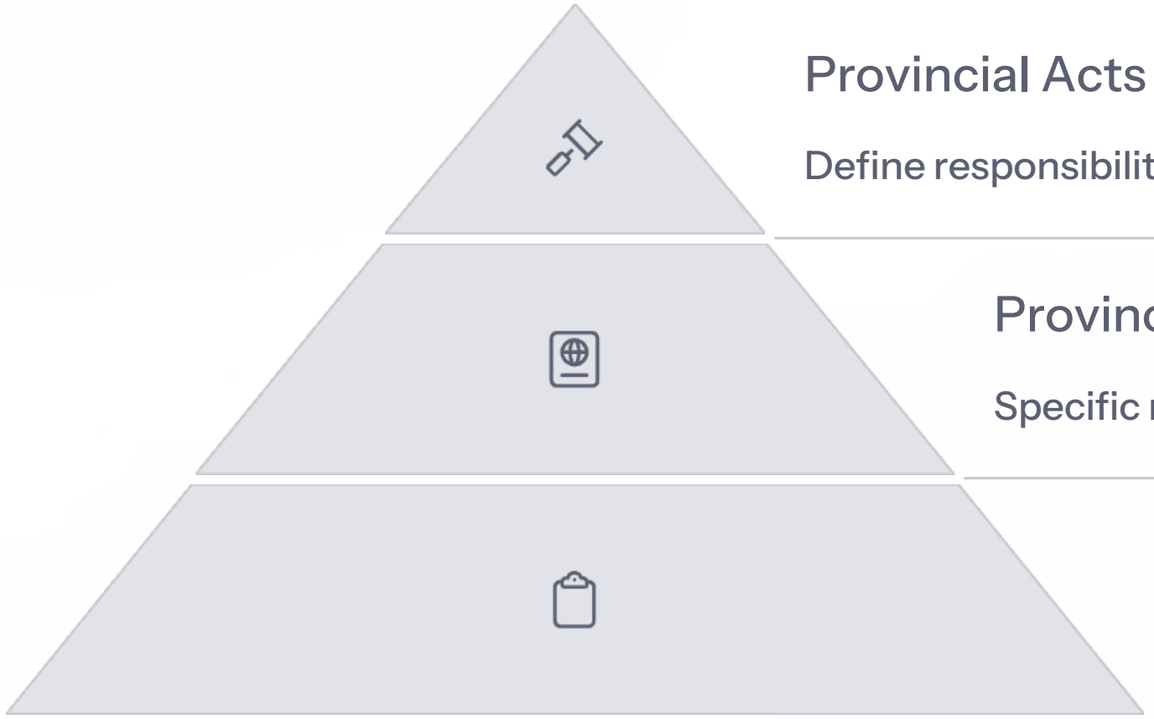
CSA B149.3 contains requirements for the field approval of non-certified or upgraded gas appliances, equipment, fuel-related components, accessories, and their assembly located downstream of the appliance manual shut-off valve.

## Structure

This Code has 20 sections and Annexes A-K (all informative), which are listed in the Contents section.

Annex B, Valve diagrams, contains symbols (see Figure B.1) and diagrams [Figures B.2 to B.11 g)].

# Acts, Regulations, and Directives



## Provincial Acts

Define responsibilities and enable regulations

## Provincial Regulations

Specific rules under the authority of acts

## Safety Directives

Periodic bulletins on product approval or installation

The gas technician/fitter needs to be aware of provincial acts and regulations that govern the installation of gas and propane equipment and the qualifications required for the persons performing the work.

# Provincial Acts

## Definition

An act is a piece of government legislation that defines or assigns responsibilities and enables the writing of regulations.

## Technician Responsibility

The gas technician/fitter should be familiar with those portions of the applicable act(s) pertaining to the gas technician's/fitter's responsibility.

## Provincial Variation

The title of the act dealing with installation of gas equipment and/or the certification of gas technicians/fitters varies from province to province.

# Provincial Regulations

## Definition

A regulation is a piece of government legislation made under the authority of an act. It is more specific than an act.

## Types

There are usually separate regulations for certification or apprenticeship, gas installations, and propane storage.

## Reference

See the various provincial regulations governing the fuels industry.


UR
GO
Company Email
Company
Company
Company Socia
Financial Regulatory Compliance Document
ncial Regulatory Compliance Document is intended to certify that [C
ereinafter referred to as the "Company," is in compliance with relevan
ancial regulations as of [Date of Certification]. This document outlines
d regulations that have been assessed, along with the results of the co
n.
atory Framework
pany operates within the regulatory framework established by variou
ancial regulatory authorities, including but not limited to:
ities and Exchange Commission (SEC)
nodity Futures Trading Commission (CFTC)
cial Industry Regulatory Authority (FINRA)
al Reserve System (FRS)
e of the Comptroller of the Currency (OCC)
umer Financial Protection Bureau (CFPB)


# Safety Directives and Bulletins

## Issuing Authority

The provincial authority having jurisdiction may periodically issue directives and bulletins

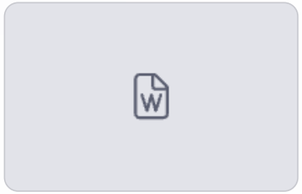
## Content Focus

Directives pertain to product approval or installation practices

## Code Adoption

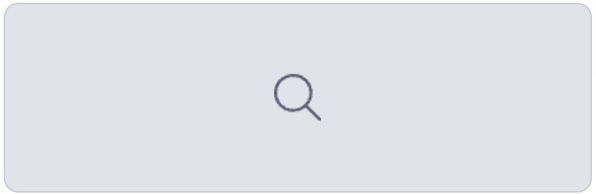
The authority having jurisdiction (AHJ) is responsible for the adoption of the national installation codes, often with changes

# Manufacturer's Specifications



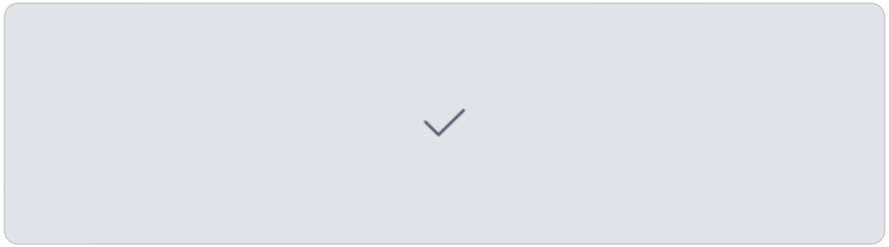
## Publication Content

Manufacturers publish specifications and certified installation instructions for their appliances and equipment



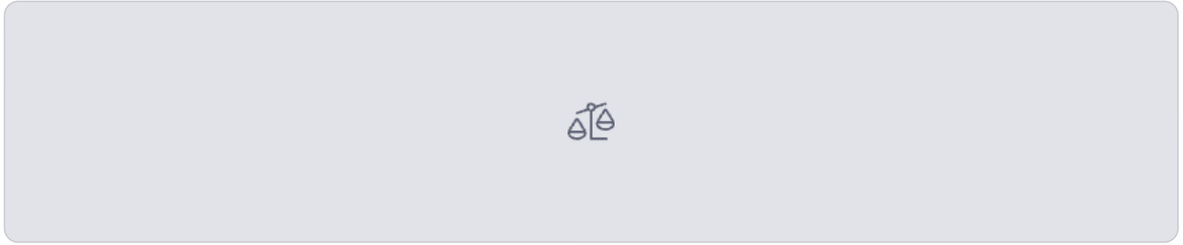
## Verification

Ensure that the installation instructions have received certification



## Certification Symbol

You should see the symbol of the certification organization printed on the cover of the instructions



## Legal Requirement

Compliance with manufacturer's certified instructions is a legal requirement

It is very important that you read the manufacturer's publications before installing an appliance and make sure that the specifications and instructions pertain to the appliance you are installing. CSA B149.1 Natural gas and propane installation code states that "[a]n appliance, accessory, component, equipment, or any other item shall be installed in accordance with the manufacturer's certified instructions and this Code."

# Information in Manufacturer's Publications

## Installation Requirements

Size of area needed for installation and service

## Physical Information

Physical dimensions of the equipment

## Identification

Model numbers and part numbers

## Gas Requirements

Gas input rate and pressure requirements also the combustion parameters

## Venting

Venting material and configuration requirements

## Air Supply

Air supply requirements

## Electrical

Electrical diagrams and electrical rating

## Operation

Operating sequence

## Maintenance

Maintenance requirements

## Troubleshooting

Troubleshooting tips

# Manufacturer's Service Bulletins

## Purpose

Manufacturer's service bulletins give the service technician the guidelines for servicing and maintaining the appliance or equipment (see Figure 1-1).

## Updates

Manufacturers also publish, as necessary, updates on equipment problems and provisions for solutions (see Figure 1-2).

# Staying Current with Information

## Internet as a Tool

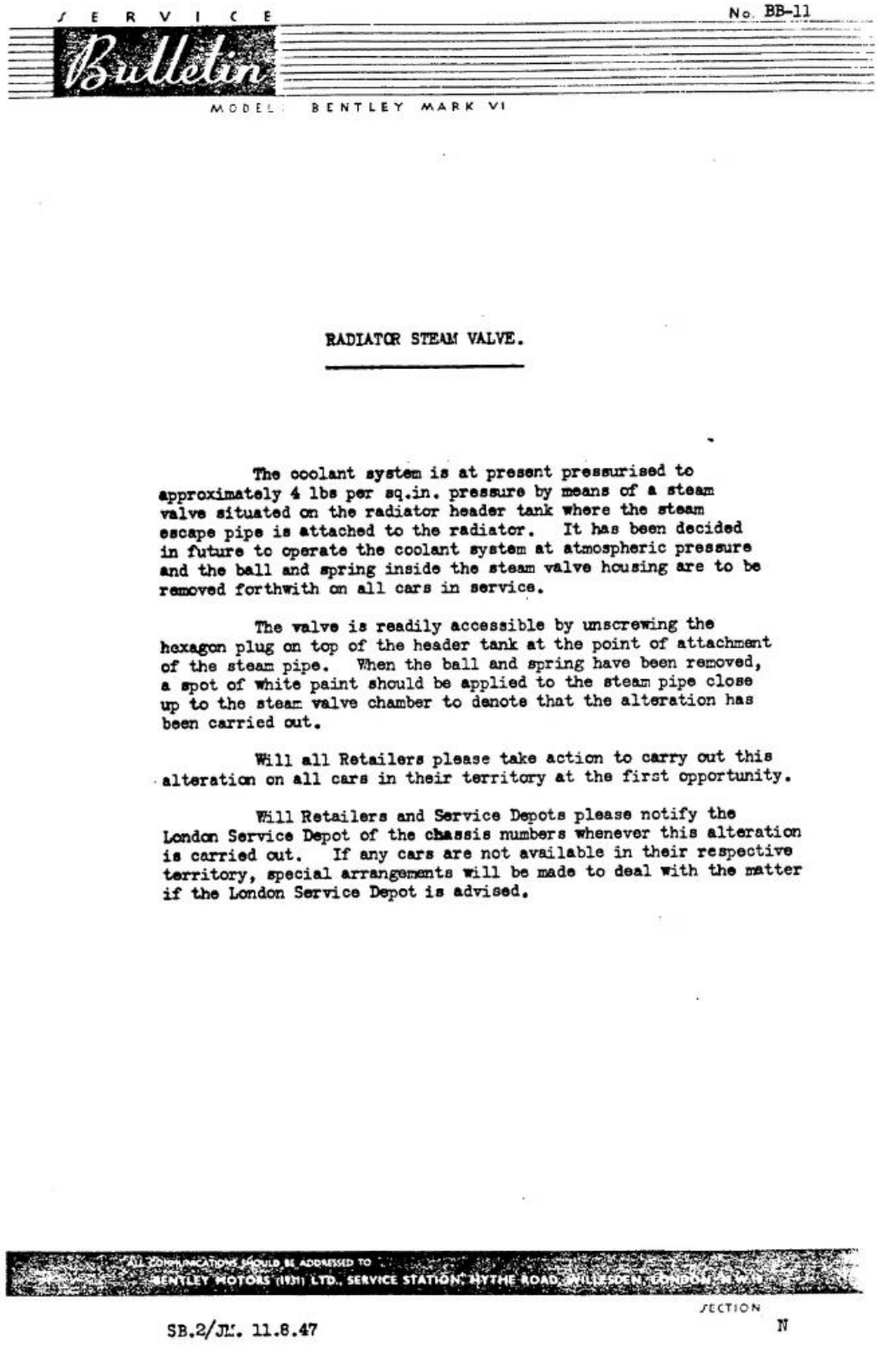
The Internet is a powerful tool for remaining current on the most up-to-date information available concerning a specific appliance or component.

## Regular Website Checks

A gas technician/fitter should check the manufacturer's website on a regular basis for any new information or service bulletin regarding the appliance or component being installed or serviced.

## Reading Materials

It is very important to carefully read all materials available from the manufacturer.



SERVICE Bulletin No. BB-11

MODEL BENTLEY MARK VI

RADIATOR STEAM VALVE.

The coolant system is at present pressurised to approximately 4 lbs per sq.in. pressure by means of a steam valve situated on the radiator header tank where the steam escape pipe is attached to the radiator. It has been decided in future to operate the coolant system at atmospheric pressure and the ball and spring inside the steam valve housing are to be removed forthwith on all cars in service.

The valve is readily accessible by unscrewing the hexagon plug on top of the header tank at the point of attachment of the steam pipe. When the ball and spring have been removed, a spot of white paint should be applied to the steam pipe close up to the steam valve chamber to denote that the alteration has been carried out.

Will all Retailers please take action to carry out this alteration on all cars in their territory at the first opportunity.

Will Retailers and Service Depots please notify the London Service Depot of the chassis numbers whenever this alteration is carried out. If any cars are not available in their respective territory, special arrangements will be made to deal with the matter if the London Service Depot is advised.

ALL COMMUNICATIONS SHOULD BE ADDRESSED TO BENTLEY MOTORS (1931) LTD., SERVICE STATION, HYTHE ROAD, WILLESDEN, LONDON, N.W.10

SECTION

SB.2/JM. 11.8.47 N

# Example of a Service Bulletin

## Bulletin Header

Heating & Air Conditioning

Goodman

DIn One LASTS AND LASTS AND LASTS."

Air Conditioning & Heating

Service Bulletin

SF-034

## Bulletin Details

DATE: April 26, 2010

TO: All Service and Parts Managers

SUBJECT: Introduction of Honeywell Gas Valves on Furnaces

# Service Bulletin Content

## Introduction

We have introduced Honeywell gas valves on single stage furnaces in March 2010 and on two stage furnaces beginning in April 2010.

## Replacement Recommendation

Service part manuals will show new part numbers with the addition of Honeywell Gas Valves. It is recommended that if a replacement gas valve is needed, it should be the same brand gas valve as the original.

1

2

3

4

## Identification

Furnaces equipped with the Honeywell gas valve will show a change in the minor revision level. Example: an "AB" revision furnace will become an "AC" revision when built with the Honeywell valve.

## Valve Differences

Single Stage: Honeywell valve is approximately ½" longer than the White-Rodgers valve. Both valves have the same ¼" push on 24 volt electrical connections.

Two Stage: Honeywell valve is approximately 1″ longer than the White-Rodgers valve. Both valves have a 3 pin harness for the 24 volt electrical connection but are different in their shape and wiring arrangements.

# Propane Kits Information

## 2

### New L.P. Kits

We have introduced two new L.P. kits for valve conversion

## LPT-03

### Single Stage Kit

Will convert a single stage Honeywell or White-Rodgers valve to L.P.

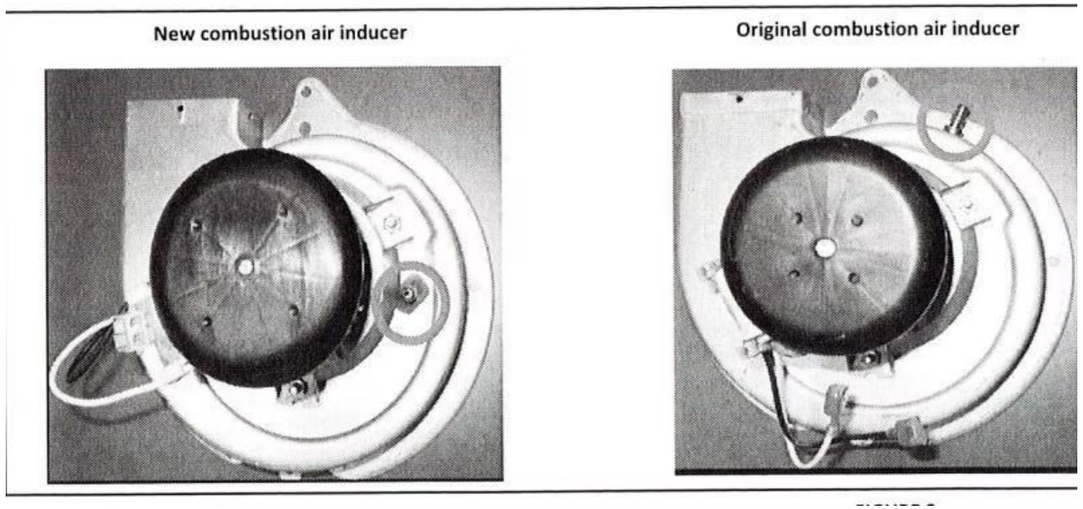
## LPM-06

### Two Stage Kit

Will convert a two stage Honeywell or White-Rodgers valve to L.P.

Existing LPT-00A and LPM-05 kits can still be used to convert White-Rodgers valves only. If replacing a White-Rodgers gas valve with a Honeywell in an LP application, it is essential that you use the Honeywell gas valve spring, do not use the spring from the WR valve.

# Service Notice Example




## Document Information

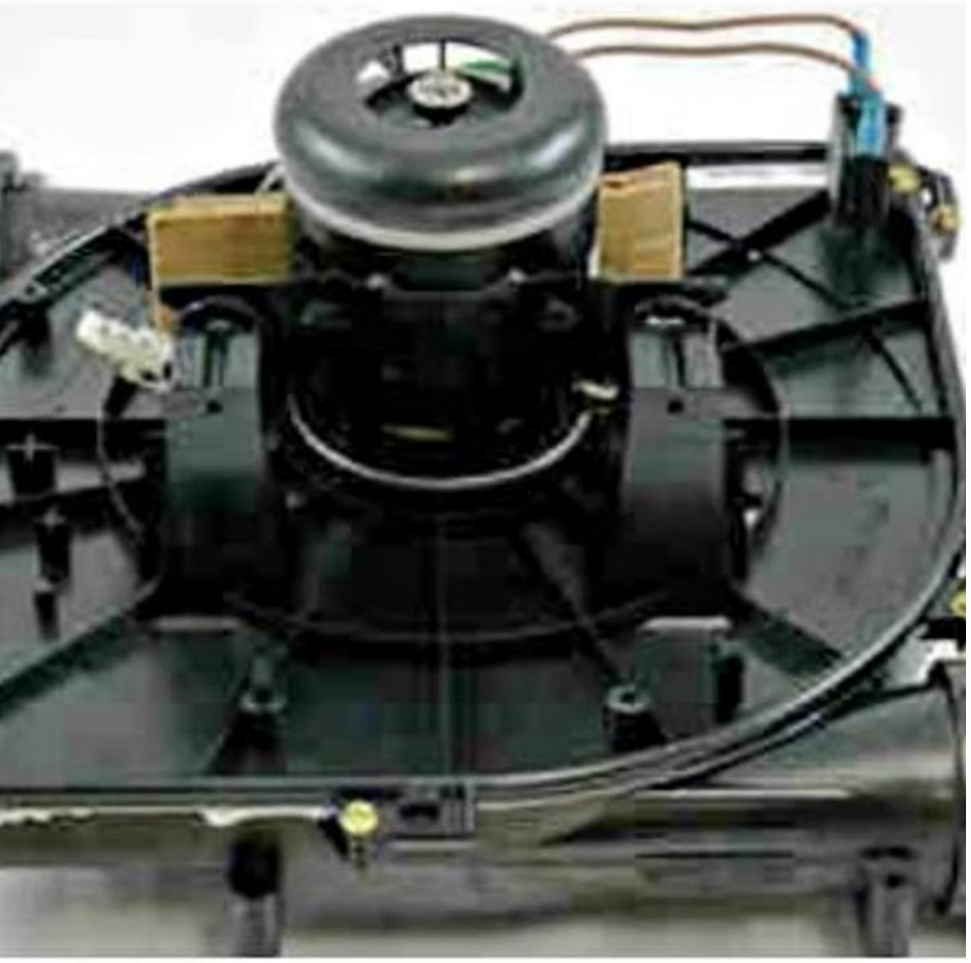
SERVICE AND APPLICATION NOTES

August 11, 2006 Revised January 2, 2009 H-06-4

New replacement combustion air inducer kits (24W95 & 43W85) For G40U, G50, & G60 furnaces

## Inducer Identification

The new inducer can be identified by the new port location on the side of the inducer body. See figure 1. The original The new inducer can be new port incurrent of the side of the inducer as a replacement for all dash number inducer being phased on and G60UH/DF furnaces.



# Combustion Air Inducer Kit Applications

| Model numbers | Kit catalog number |
| --- | --- |
| G40UH, G40DF, G50UH & G50DF | 24W95 |
| G60UH(V) & G60DF(V) | 43W85 |

These combustion air inducer replacement kits are applied as necessary to furnaces as listed in table 1.

# Pressure Switch Compatibility

## Compatibility Check

G40DF, G40UH, G50DF and G50UH units with dash numbers of 14 or earlier or G60DF(V) and G60UH(V) units with dash numbers of 8 or earlier – existing pressure switch may not be compatible with replacement combustion air inducer.

## Verification Process

Check pressure switch part number against required part number listed in table 2 and replace if necessary.

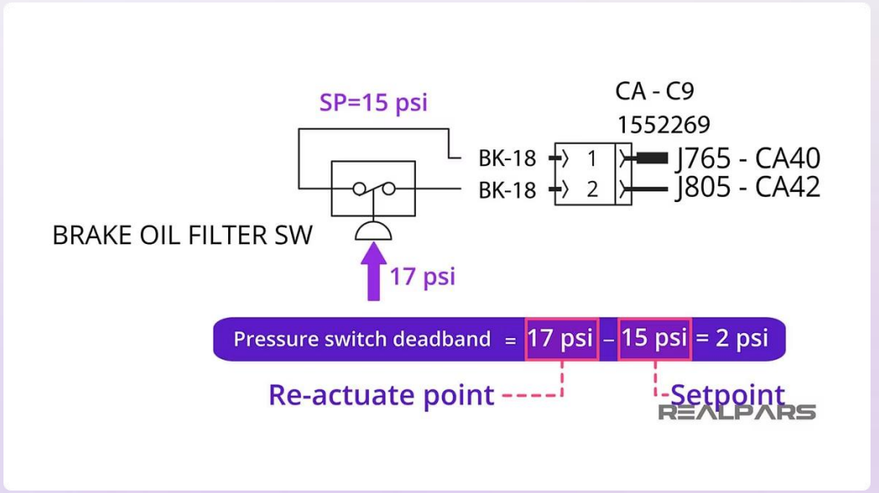
## Reference Table

Model numbers | 0 - 7,500 feet | 7,501 - 10,000 feet

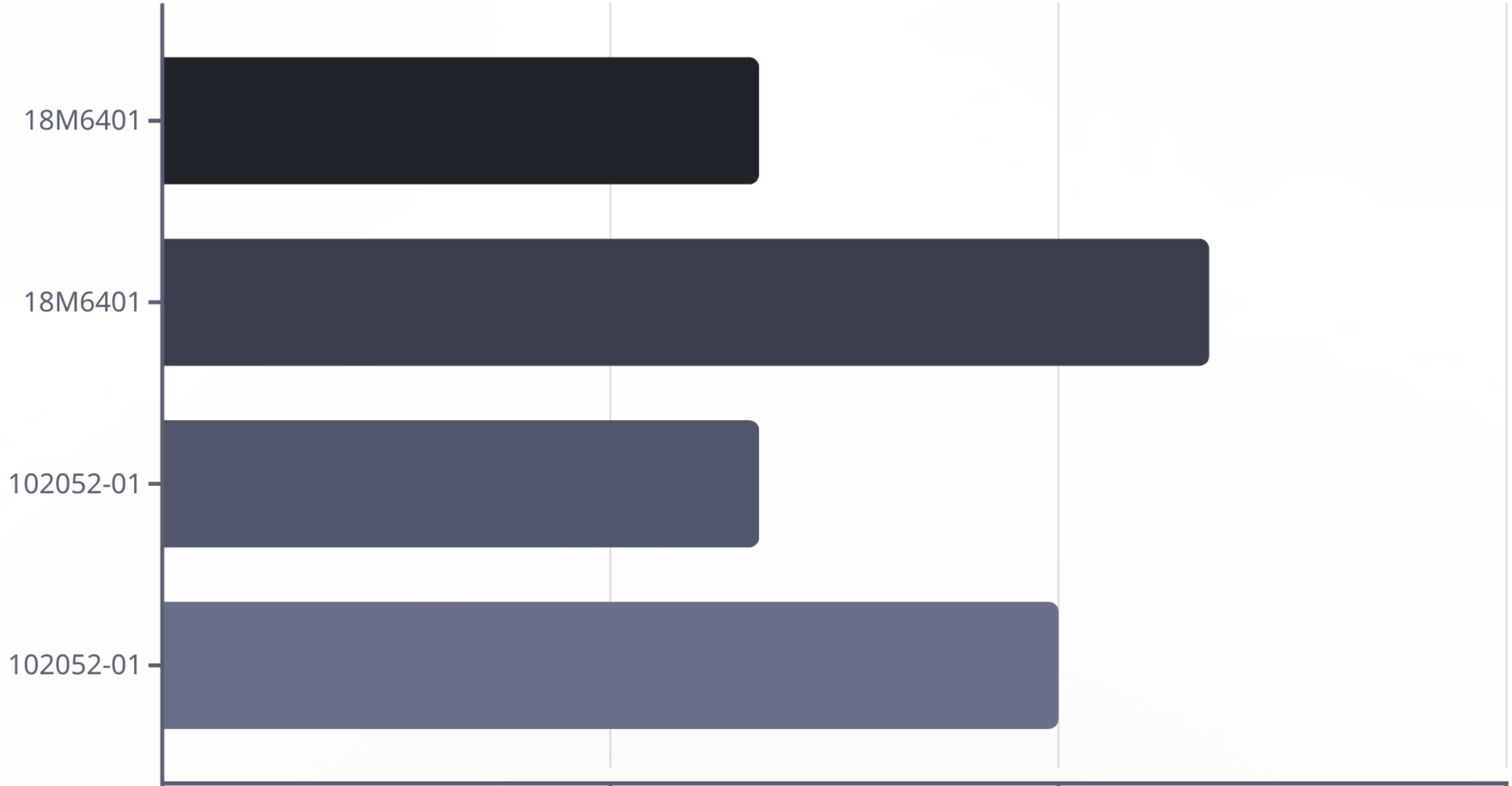
Pressure switch cat number | Pressure switch part number | Setpoint (inches w.c)

# Pressure Switch Specifications

| Pressure switch cat number | Pressure switch part number | Setpoint (inches w.c.) |
|---|---|---|
| 24W97 | 101231-01 | 0.40 |
| 561 32 | 5613201 | 0.36 |
| 24W98 | 101231-02 | 0.31 |
| 24W98 | 101231-02 | 0.31 |
| 18M61 | 18M6101 | 0.20/0.40 |
| 18M64 | 18M6401 | |



## Additional Pressure Switch Specifications



# Manufacturer Information


LENNOX )

# CSA Unit 6

# Chapter 2
# Technical Manuals and Manufacturer's Specifications

## 36 " GAS RANGE INSTALLATION INSTRUCTIONS

**INSTALLATION AND SERVICE MUST BE PERFORMED BY A QUALIFIED INSTALLER.**
**IMPORTANT: SAVE FOR LOCAL ELECTRICAL INSPECTOR'S USE.**
**READ AND SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE.**

**WARNING If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.**

**FOR YOUR SAFETY:**
- **Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.**
- **WHAT TO DO IF YOU SMELL GAS:**
- **Do not try to light any appliance.**
- **Do not touch any electrical switch; do not use any phone in your building.**
- **Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.**
- **If you cannot reach your gas supplier, call the fire department.**
- **Installation and service must be performed by a qualified installer, service agency or the gas supplier.**

**Appliances Installed in the state of Massachusetts:**
This Appliance can only be installed in the state of Massachusetts by a Massachusetts licensed plumber or gasfitter.

This appliance must be installed with a 3 foot (36 in.) long flexible gas connector.

A "T" handle type manual gas valve must be installed in the gas supply line to this appliance.

### Dimensions and Clearance

Provide adequate clearance between range and adjacent combustible surfaces.

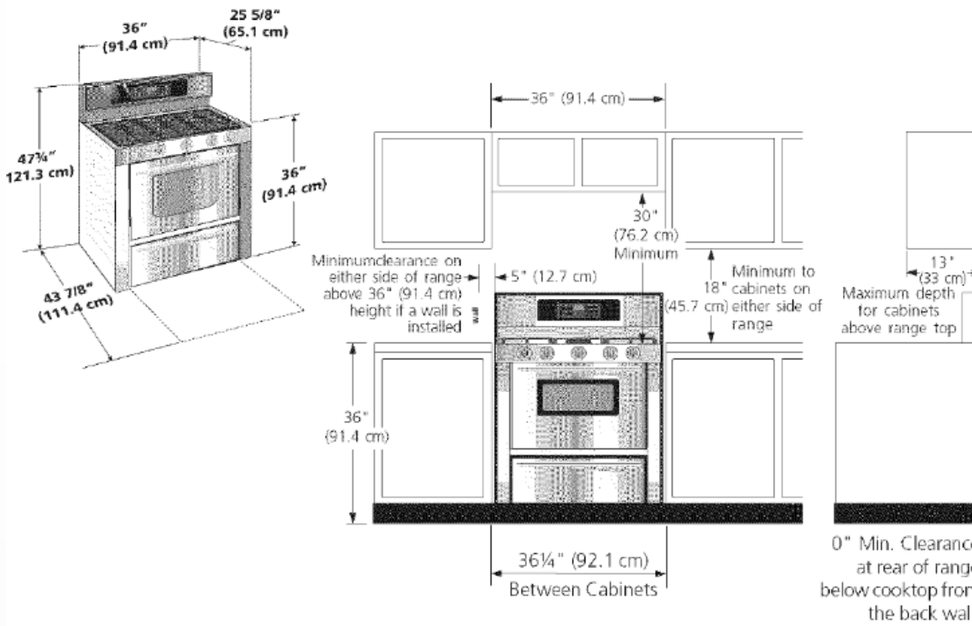



**Figure 1**

**TE: Wiring diagram for this appliance is enclosed in this booklet.**

ted in United States

P/N 318201759 (0605) Rev
English – pages
Español – páginas 8
Wiring Diagram - pages

# Overview

## Technical Documentation

Manufacturer's technical manuals and specifications are essential resources for gas technicians and fitters. These documents provide critical information needed for proper installation, maintenance, and troubleshooting of gas appliances.

## Professional Application

Understanding how to interpret and apply the information in these manuals is a fundamental skill for anyone working with gas appliances. This knowledge ensures safe and efficient installations while helping technicians quickly resolve issues when they arise.

# Purpose

## Reference Material

Technical manuals serve as comprehensive reference materials for gas technicians during all phases of work with gas appliances.

## Installation Guidance

These documents provide specific instructions for proper installation of gas appliances according to manufacturer requirements.

## Troubleshooting Support

Manuals include diagnostic information to help technicians identify and resolve problems efficiently.

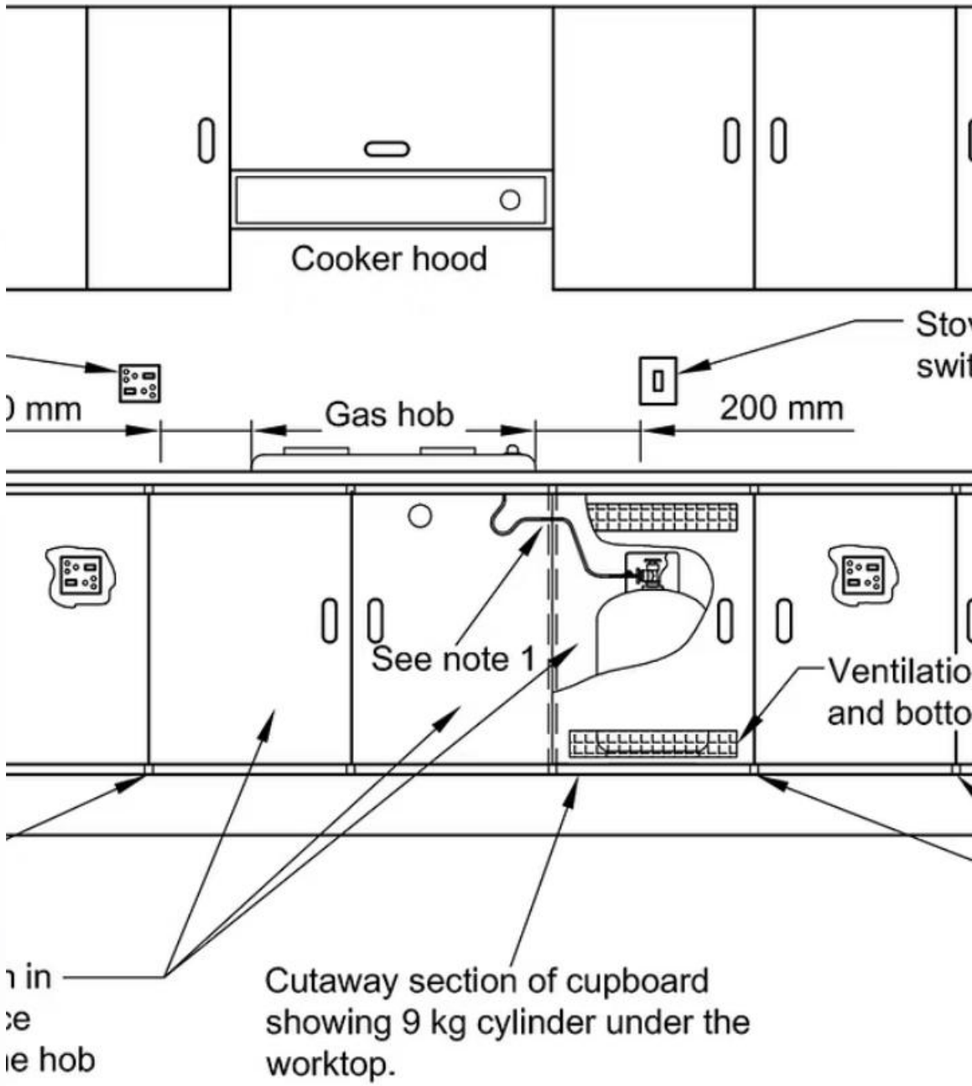
# Importance of Technical Documentation

## Installation Reference

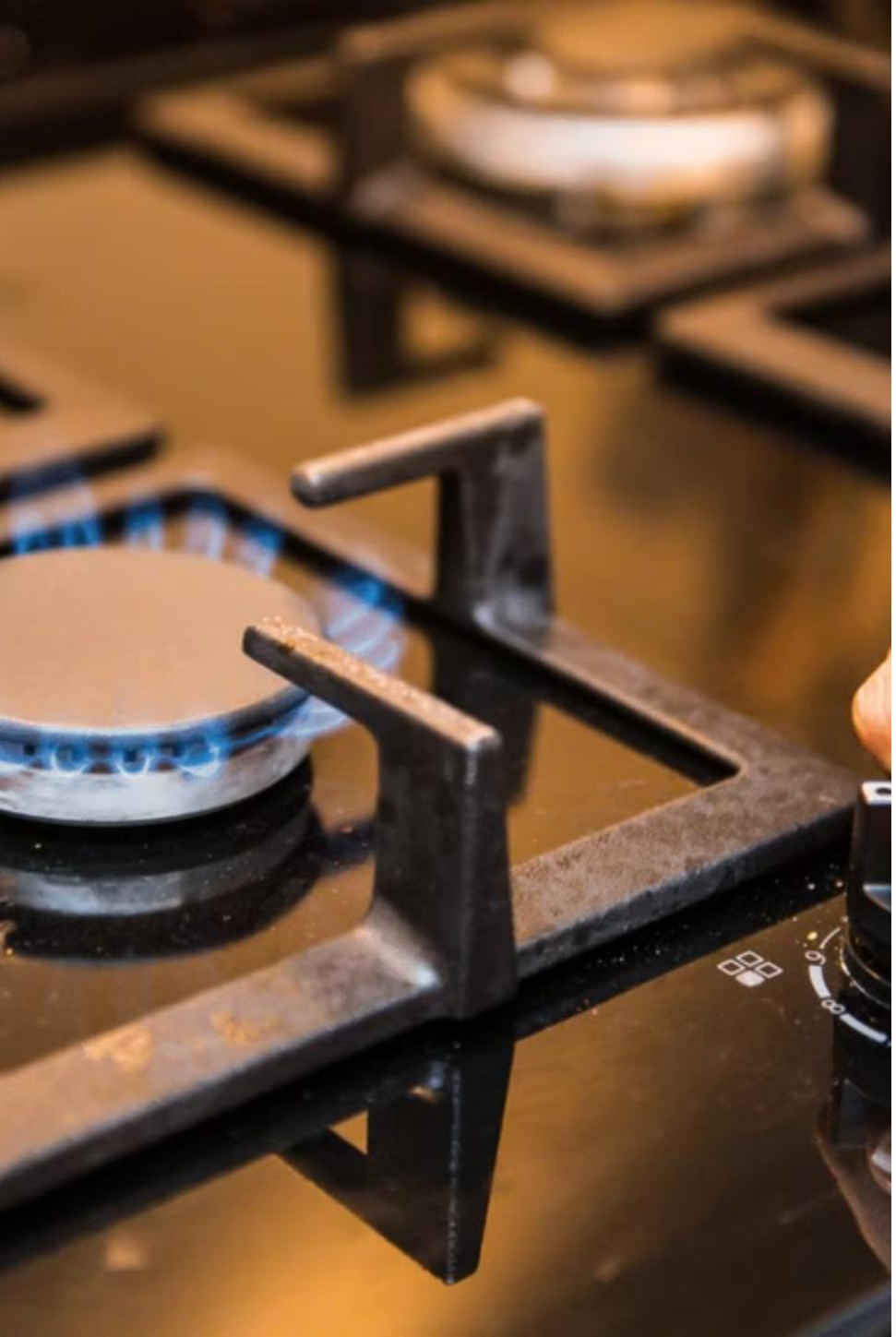
Manufacturer's technical manuals and specifications are materials that the gas technician/fitter will need for installations, parts replacement, or troubleshooting procedures. This Chapter will explain where the various data is located and how the technician/fitter can interpret it.

## Data Interpretation

Understanding how to locate and interpret technical information is essential for performing gas work safely and effectively. Technicians must be able to navigate various formats of documentation across different manufacturers.




es not pass through the solid partition or divider between the cu
hosetail (see figure 5) on each side passes through and is fixe
is attached to the hosetail in the cupboard in which the cylind
d to the hosetail in the cupboard space under the hob.



# Objectives

## Learning Goals

At the end of this Chapter, you will be able to:

- locate manufacturer's installation data; and
- troubleshoot problems.

## Practical Application

These skills will enable technicians to efficiently install gas appliances according to manufacturer specifications and resolve issues that may arise during operation.

## Safety Compliance

Understanding technical documentation ensures installations meet safety standards and manufacturer requirements.

BLE
MAKING BUILDINGS SAFER

# Technical Manual
## (European Standards)

Version 1.0 (0517)

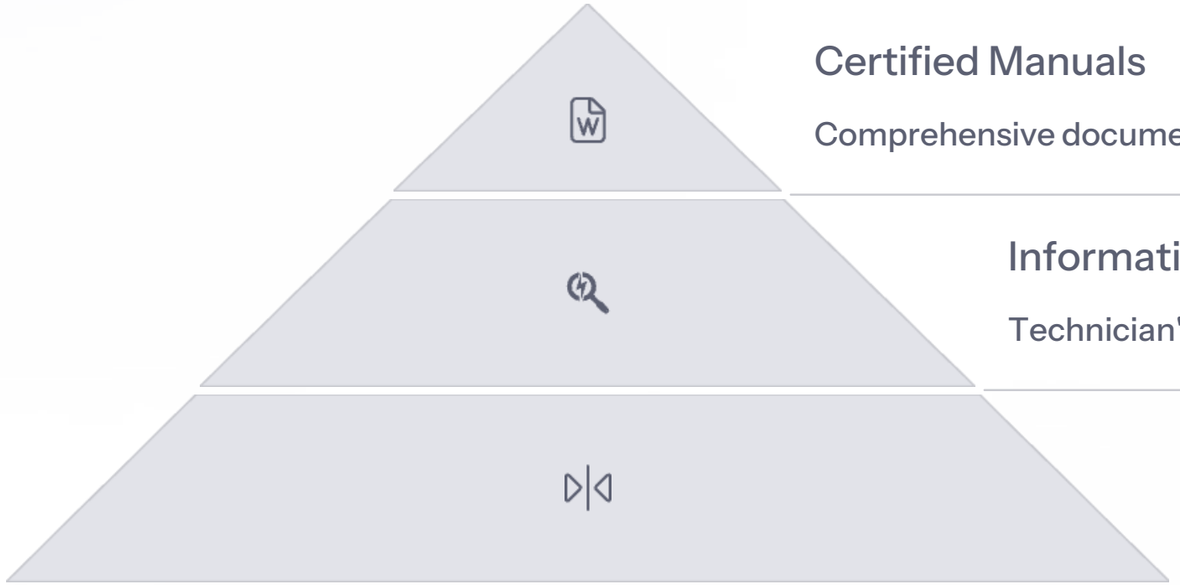
- System Overview
- Installation
- Maintenance & Troubleshooting
- Manufacturing Information

BLE MAKING BUILDINGS SAFER
THE LEADING EDGE IN Smoke & Fire Curtains
Office Tel: 0114 251 4703 Email: enquiries@blecurtains.com
Website: www.ble-smokeandfirecurtains.com

# Terminology

| Term | Abbreviation (symbol) | Definition |
|---|---|---|
| Manufacturer's certified installation and service manual | | From a manufacturer, document with all necessary information for the installation and basic maintenance of an appliance |
| Troubleshooting procedure | | Series of specific steps to locate the source of a problem to make the product or process operational again |

# Manufacturer's Installation Data



### Certified Manuals

Comprehensive documentation provided by manufacturers

### Information Location

Technician's responsibility to find relevant data

### Installation Requirements

Tools, hardware, wiring, and piping specifications

Manufacturers provide certified installation and service manuals with their appliances. Although the literature varies from company to company and from product to product, the manual will include all necessary information for the installation and basic maintenance of the appliance. It is up to the gas technician/fitter to find it!

The following excerpts from manufacturer's manuals show the various ways of presenting installation information. Again, it is up to the gas technician/fitter to read the complete manual and study the charts and diagrams before work connences in order to begin locating the collecting the tools, hardware, wiring, and piping needed for a trouble-free instalation.

Gas appliance manufacturer's installation instructions typically include a list of tools and measuring instruments needed to complete the instally induce anist of tools and on how to uncrate, locate, install, test, and commission the appliance.

# Model Number

# Tools and Hardware

## Leveling Equipment

Level each Unit by adjusting levelling bolts or legs. Use a spirit level and level Unit four ways.... Lover cather entil special disc type thermocouple, or reliable "surface" type thermometer.

## Fastening Hardware

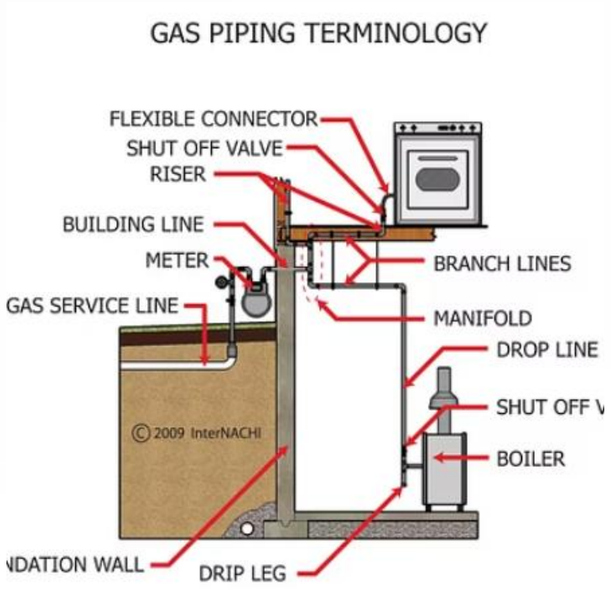
They may also indicate when hardware is supplied, for example:

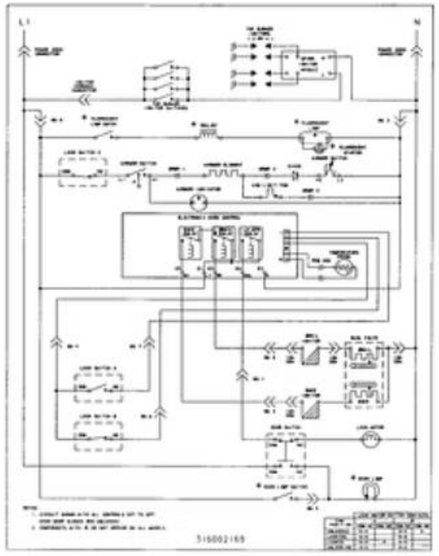
Secure in place with two hex nuts supplied.

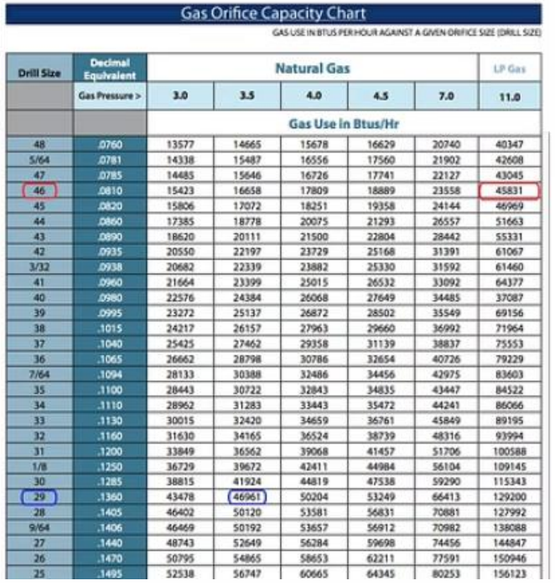
## Manufacturer Specifications

Manufacturers will often indicate the tools and hardware required for the installation, as shown by the following examples.

# Wiring and Piping



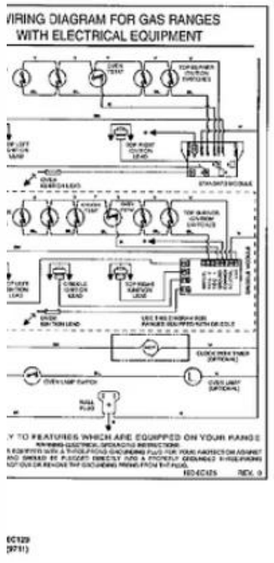





Gas Orifice Capacity Chart

GAS USE IN BTUS PER HOUR AGAINST A GIVEN ORIFICE SIZE (DRILL SIZE)

| Drill Size | Decimal Equivalent | Natural Gas | | | | | LP Gas |
|---|---|---|---|---|---|---|---|
| | Gas Pressure > | 3.0 | 3.5 | 4.0 | 4.5 | 7.0 | 11.0 |
| | | Gas Use in Btus/Hr | | | | | |
| 48 | .0760 | 13577 | 14665 | 15678 | 16629 | 20740 | 40347 |
| 5/64 | .0781 | 14338 | 15487 | 16556 | 17560 | 21902 | 42608 |
| 47 | .0785 | 14485 | 15646 | 16726 | 17741 | 22127 | 43045 |
| 46 | .0810 | 15423 | 16658 | 17809 | 18889 | 23558 | 45831 |
| 45 | .0820 | 15806 | 17072 | 18251 | 19358 | 24144 | 46969 |
| 44 | .0860 | 17385 | 18778 | 20075 | 21293 | 26557 | 51663 |
| 43 | .0890 | 18620 | 20111 | 21500 | 22804 | 28442 | 55331 |
| 42 | .0935 | 20550 | 22197 | 23729 | 25168 | 31391 | 61067 |
| 3/32 | .0938 | 20682 | 22339 | 23882 | 25330 | 31592 | 61460 |
| 41 | .0960 | 21664 | 23399 | 25015 | 26532 | 33092 | 64377 |
| 40 | .0980 | 22576 | 24384 | 26068 | 27649 | 34485 | 67087 |
| 39 | .0995 | 23272 | 25137 | 26872 | 28502 | 35549 | 69156 |
| 38 | .1015 | 24217 | 26157 | 27963 | 29660 | 36992 | 71964 |
| 37 | .1040 | 25425 | 27462 | 29358 | 31139 | 38837 | 75553 |
| 36 | .1065 | 26662 | 28798 | 30786 | 32654 | 40726 | 79229 |
| 7/64 | .1094 | 28133 | 30388 | 32486 | 34456 | 42975 | 83603 |
| 35 | .1100 | 28443 | 30722 | 32843 | 34835 | 43447 | 84522 |
| 34 | .1110 | 28962 | 31283 | 33443 | 35472 | 44241 | 86066 |
| 33 | .1130 | 30015 | 32420 | 34659 | 36761 | 45849 | 89195 |
| 32 | .1160 | 31630 | 34165 | 36524 | 38739 | 48316 | 93994 |
| 31 | .1200 | 33849 | 36562 | 39068 | 41457 | 51706 | 100588 |
| 1/8 | .1250 | 36729 | 39672 | 42411 | 44984 | 56104 | 109145 |
| 30 | .1285 | 38815 | 41924 | 44819 | 47538 | 59290 | 115343 |
| 29 | .1360 | 43478 | 46961 | 50204 | 53249 | 66413 | 129200 |
| 28 | .1405 | 46402 | 50120 | 53581 | 56831 | 70881 | 127992 |
| 9/64 | .1406 | 46469 | 50192 | 53657 | 56912 | 70982 | 138088 |
| 27 | .1440 | 48743 | 52649 | 56284 | 59698 | 74456 | 144847 |
| 26 | .1470 | 50795 | 54865 | 58653 | 62211 | 77591 | 150946 |
| 25 | .1495 | 52538 | 56747 | 60665 | 64345 | 80253 | 156123 |



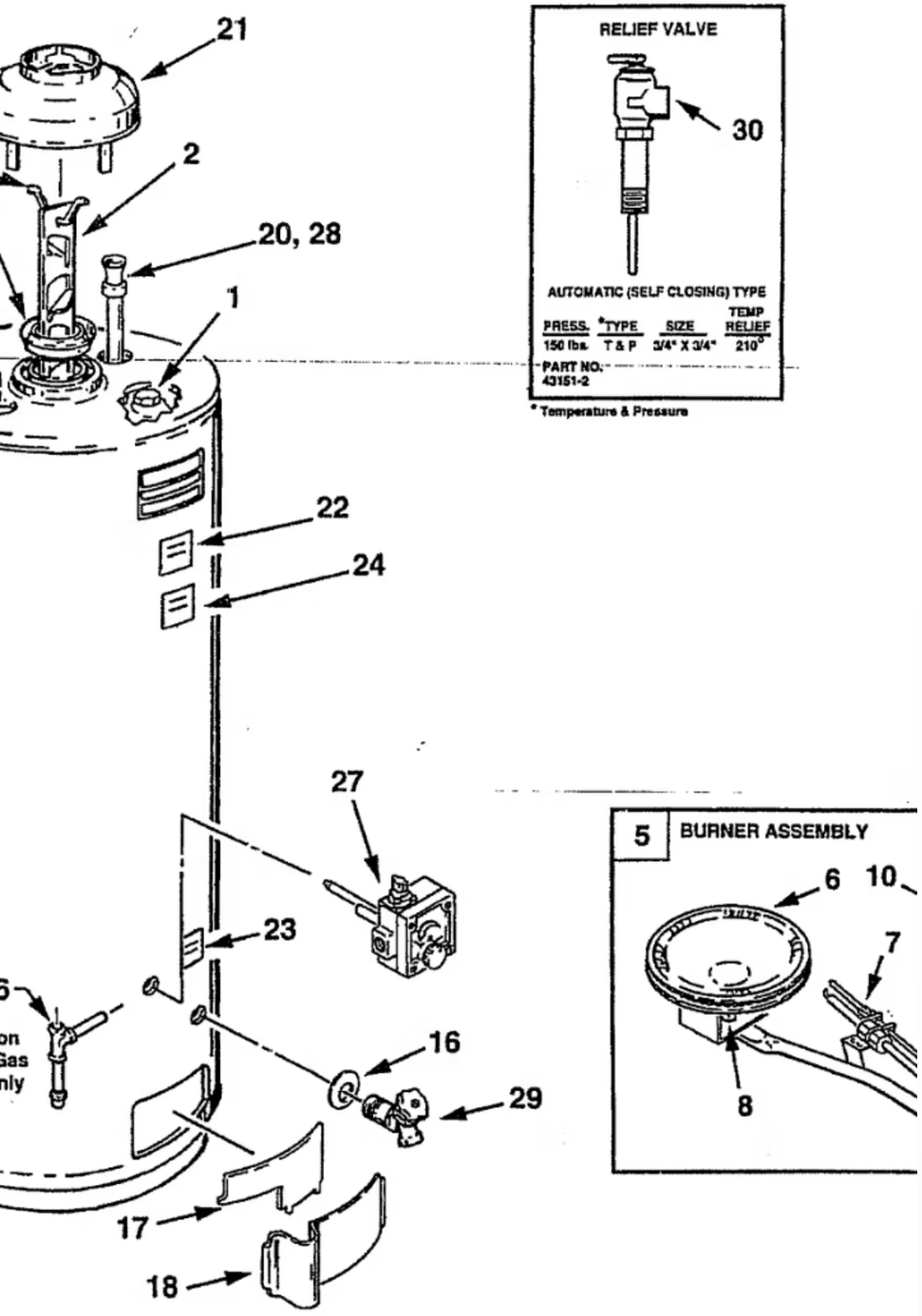


Most manuals come with wiring and piping diagrams that often come with schedules (Table 2-2) and keys (Table 2-3).

| Gas pilot orifice schedule | Natural gas | LP gas |
|---|---|---|
| J(R) 15A-10, J(R) 30A-10(12), J50A-15-flame rod | Std. #44 | N/A |
| J(R) 15A-10, J(R) 30A-10(12) Scanner | Std. #36 | Std. #44 |
| J50A-15 Scanner | Std. #36 | Std. #44 |

Table 2-2 Example of gas orifice schedule

| Description | Key | Component |
|---|---|---|
| A67 | Receiver-infrared | |
| B3 | Motor-blower | |
| GV1 | Valve-gas-millivolt | |
| R32 | Potentiometer | |










# Replacement Parts

## 63°F

### Temperature Rise

Maximum temperature rise for replacement wire

## 35°C

### Celsius Equivalent

Metric temperature specification for wire

## TW

### Wire Type

Specific wire type code for replacements

The manuals will sometimes specify details on the replacement parts, as shown in the following example: example:

Replacement wire must be type "TW" (63°F or 35 °C temperature rise) wire or equivalent.

# Troubleshooting Problems

### Identify Problem

Recognize symptoms and gather information

### Consult Manual

Reference manufacturer's troubleshooting guides

### Repair/Replace

Fix or replace faulty components

### Test Components

Perform diagnostic tests on suspected parts

This section provides general information about troubleshooting problems. Its purpose is to help you develop a consistent, analytical approach to troubleshooting problems.

## Troubleshooting procedure

In any troubleshooting situation, it is necessary to consider the entire system and sequence of operation including not only the burner, controls, witness such as a many of the supply, fuel supply, fuel supply, and the condition and characteristics of the flame itself. In order to cover all areas of burner operation, the troubleshooting procedure is broken

# Step 1: Know the System

## Study Technical Manuals

In other words, do your homework. Study the manufacturer's technical manuals. Know how the system works.

## Stay Updated

Keep up with the latest service bulletins. Read them and them in a handy place. This month's bulletin may cover the more the mon the their me their in a nandy places. The cause and remed

## Build Knowledge

Understanding the system thoroughly is the foundation of effective troubleshooting. Familiarize yourself with all components and their functions.

# Step 2: Ask Questions and Look for Symptoms

## 1 Gather Information

Usually, the information available on arrival at the installation consists of a simple statement such as "The burner shuts down." Start by asking all the installation consisted of anyone that might have some knowledge of what happened.

## 2 Ask Specific Questions

For example:

- When does the shutdown occur?
- What part of the cycle?
- How long after the startup?
- Does a shutdown occur after every start?
- How is the light off?

## 3 Observe Symptoms

These are only sample questions. The information you need will depend on the individual situation situation.

Examine the equipment and look for symptoms. A symptom is a sign that the equipment is operating abnormally (e.g., discoloration is a symptom of excessively high heat).

# Step 3: Evaluate Your Information

## Consult Resources

Use the supplied manufacturer's manuals, charts, service suggestions

## Apply Experience

Combine documentation with personal knowledge

## Form Hypothesis

Develop initial theories about the problem

Use the supplied manufacturer's manuals, charts, service suggestions, together with your personal experience, to evaluate any information you have concerning the problem.

The conclusions you have drawn at this stage only provide an idea of where to look for the exact solution to the problem.

# Step 4: Make a Trial Run

## Cycle the System

Cycle the burner system and observe.

## Observe Operation

- Was each step of the startup according to the design sequence?
- Did any deviations occur?
- Did the shutdown occur exactly as described?
- Did anything else happen?
- Have any new facts been established

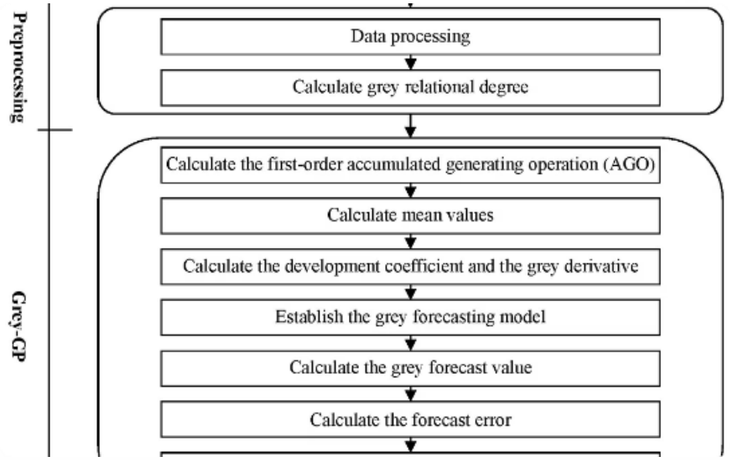
## Document Findings

While you perform the trial run, make a note of any new information.

# Step 5: Re-evaluate

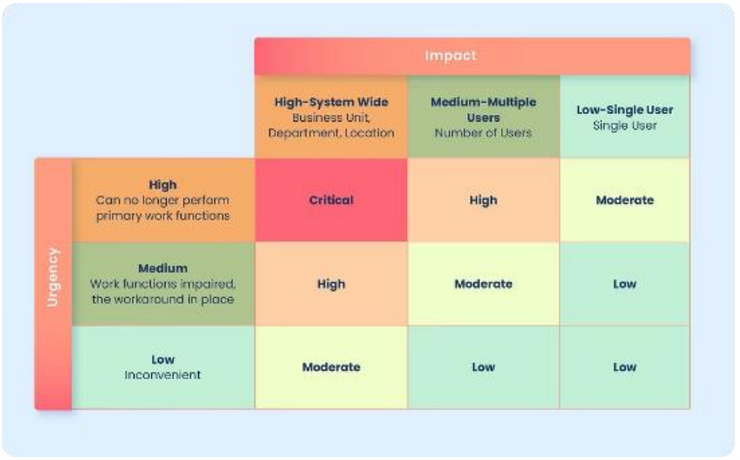

## Ongoing Assessment

You can often make the re-evaluation of available facts during the trial run. Look over your list of possible causes and decide which are most likely and which are easiest to verify.




## Multiple Factors

Remember that in some instances, more than one factor may be contributing to the problem and you must consider this in the solution.




## Prioritize Solutions

Reach your decision on the leading causes and plan to check them first.

# Steps 6-7: Test and Correct

## Step 6: Test Your Conclusions

After determining the apparent cause(s) of the appliance problem, perform a second test run to Aller dotomining the uppers. If you have not found the answer, you must make a new See if the ovaluation is on our information that you have obtained during the second test run. More than one re-evaluation test may be necessary to get all the information you need to positively identify the cause(s) of the problem.

## Step 7: Correct the Condition(s)

At this stage, you would be confident in adjusting or replacing the faulty part(s). (Note that you At this Stuge, you would be connect with the manufacturer's manual.) Do a final run-through cannot adjust all parts in the first - solerent parts, make sure that you provide the model number of the equipment.

# Manufacturer's Troubleshooting Guide

| Nature of trouble | Possible Cause |
| --- | --- |
| Unable to light Pilot | 1. Gas knob dial not correctly positioned<br>2. Pilot orifice clogged<br>3. Pilot tube pinched or clogged<br>4. Air in gas line |
| Pilot does not stay lit when red button is released | 5. Loose Thermocouple<br>6. Thermocouple breakdown<br>7. Safety magnet breakdown<br>8. Thermostat's single use gas shut-off device has opened |
| Not enough hot water | 9. Heater undersized<br>10. Low gas pressure |
| Water too hot or not hot enough | 11. Thermostat setting too high or low<br>12. Thermostat out of calibration<br>13. High water temperature |
| Yellow flame | 14. Scale on top of burner<br>15. Combustion air inlets on flueway restricted<br>16. Not enough combustion or ventilation air supplied to the room |
| Rumbling noise | 17. Scale or sediment in tank |

CAUTION!

For your safety, DO NOT attempt to repair thermostat, burner or gas piping. Refer repairs to qualified service personnel.

# Obtaining Service Assistance

## Contact Installer First

1. Should you have any questions about your new water heater, or if it requires adjustment, repair, or routine maintenance. It is suggested that you first contact your installer, plumbing contractor or previously agreed upon service agency. In the event that the firm has moved, on is unavailable, refer to the telephone directory commercial listing or local utility for qualified service assistance.

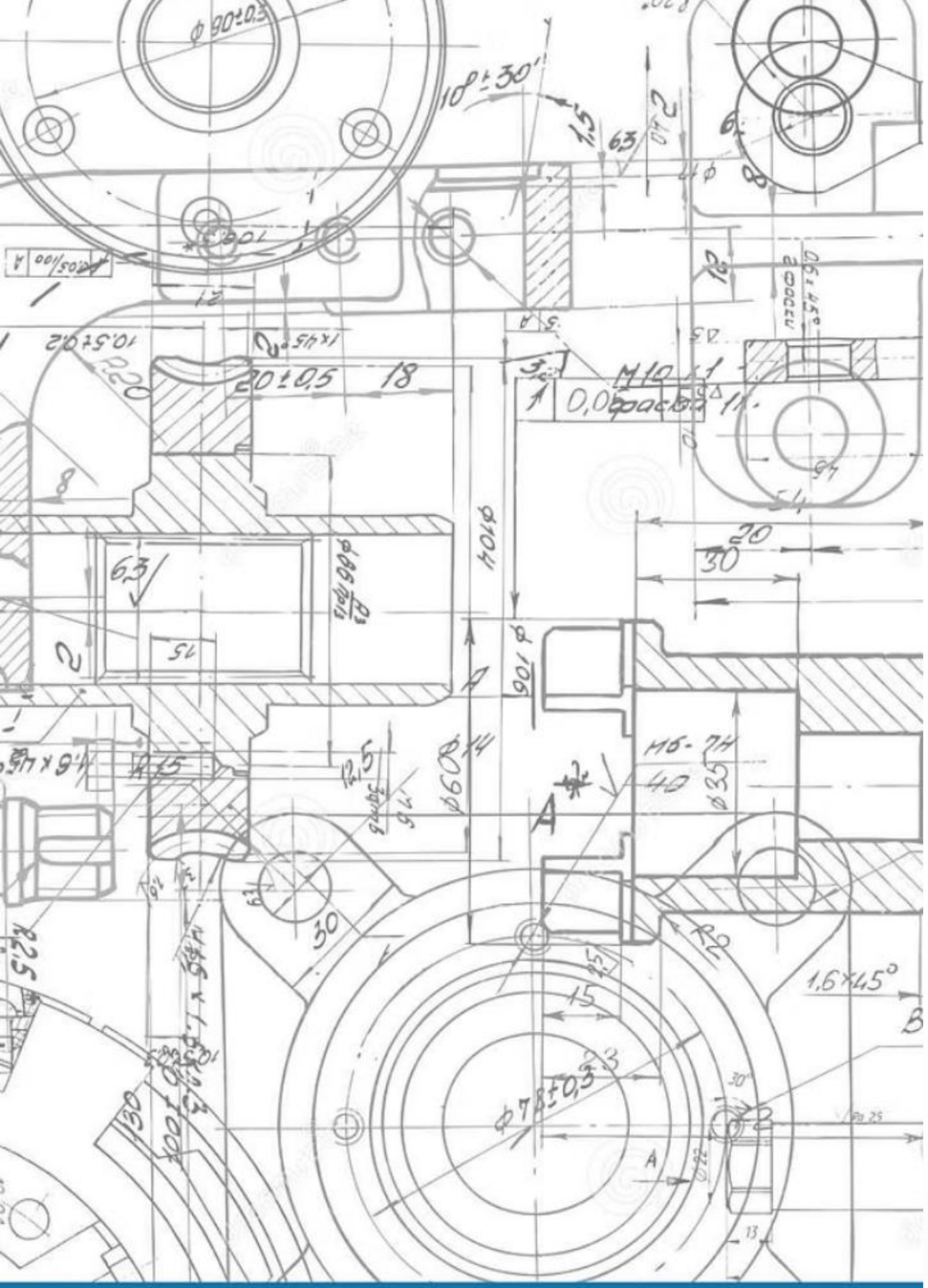
## Contact Manufacturer If Needed

2. Should your problem not be solved to your complete satisfaction, you should contact the Manufacturer's Regional Service Manager at the office closest to your location as listed below or the National Service Department at 1-800-000-000.

## Provide Required Information

When contacting the manufacturer, the following information should be made available:

1. Model and serial numbers of the water heater as shown on the name plate on the jacket of the heater.
2. Address where the water heater is located and can be seen.
3. Name and address of installer and any service agency who performed service on the water heater.
4. Date of original installation and dates any service work was performed.
5. Details of the problem as you can best describe them.
6. List of people, with dates, who have been contacted regarding this issue.



# CSA Unit 6

# Chapter 3
# Mechanical Drawings and Specifications

Mechanical drawings are essential tools in the gas industry, serving as "maps" that guide technicians in understanding where to install appliances and connect gas piping. Gas technicians and fitters must develop a strong understanding of how to interpret these important drawings and the symbols used in them to perform their work effectively.

# Purpose of Mechanical Drawings

## Essential Tools

Mechanical drawings serve as necessary tools in the gas industry, providing detailed information about installation locations and connection points.


## Technical Guidance

These drawings act as "maps" that guide technicians in understanding exactly where to install appliances and where to connect gas piping.

# Learning Objectives

## Describe Basic Drawing Views

Understand different perspectives and projections used in mechanical drawings.

## Describe Types of Drawings

Identify and understand various drawing types used in the gas industry.

## Describe Lines and Symbols

Recognize and interpret the various lines and symbols used in mechanical drawings.

## Describe Supplements to Mechanical Drawings

Understand additional documentation that accompanies drawings.

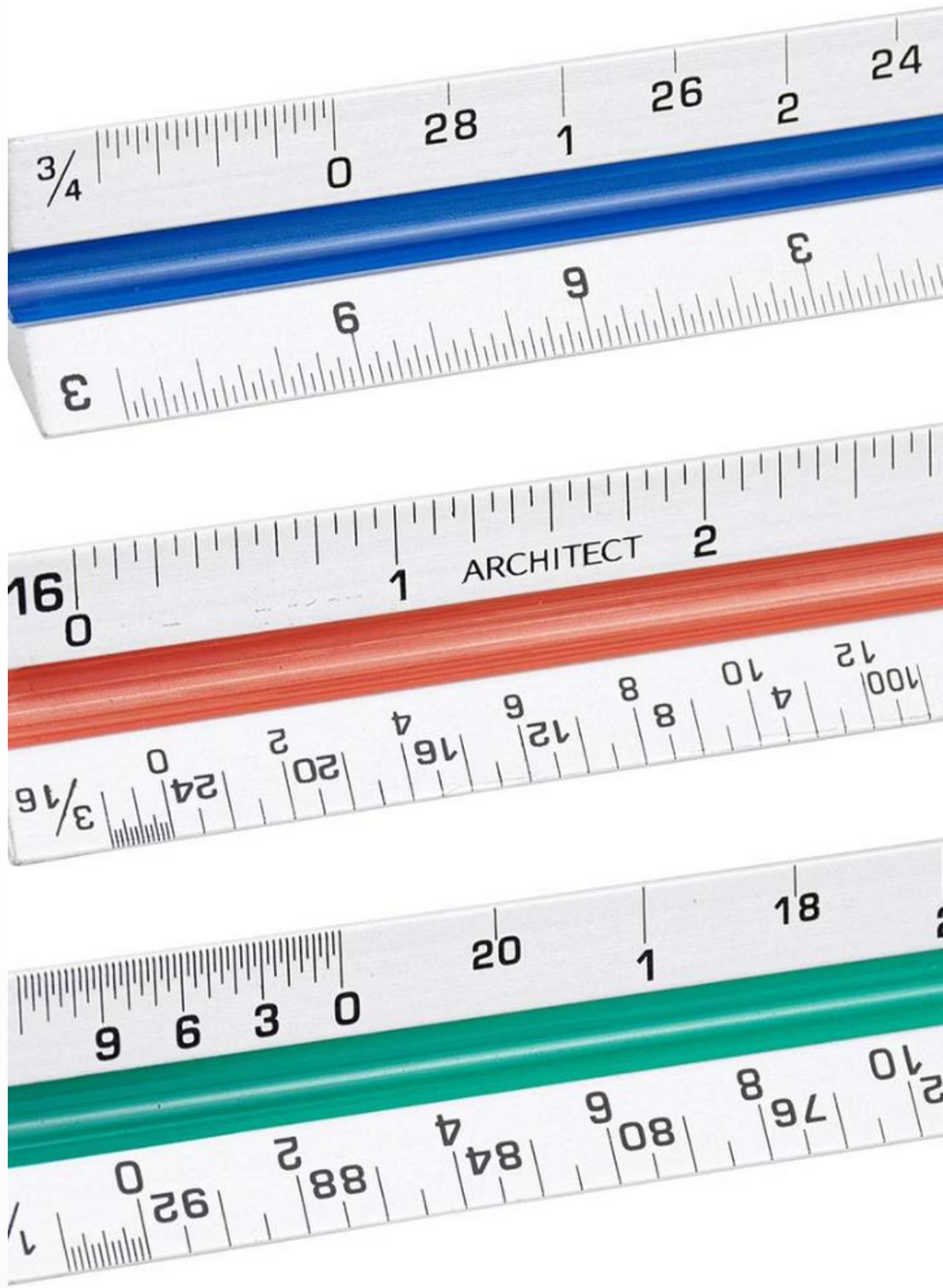
## Interpret a Mechanical Drawing

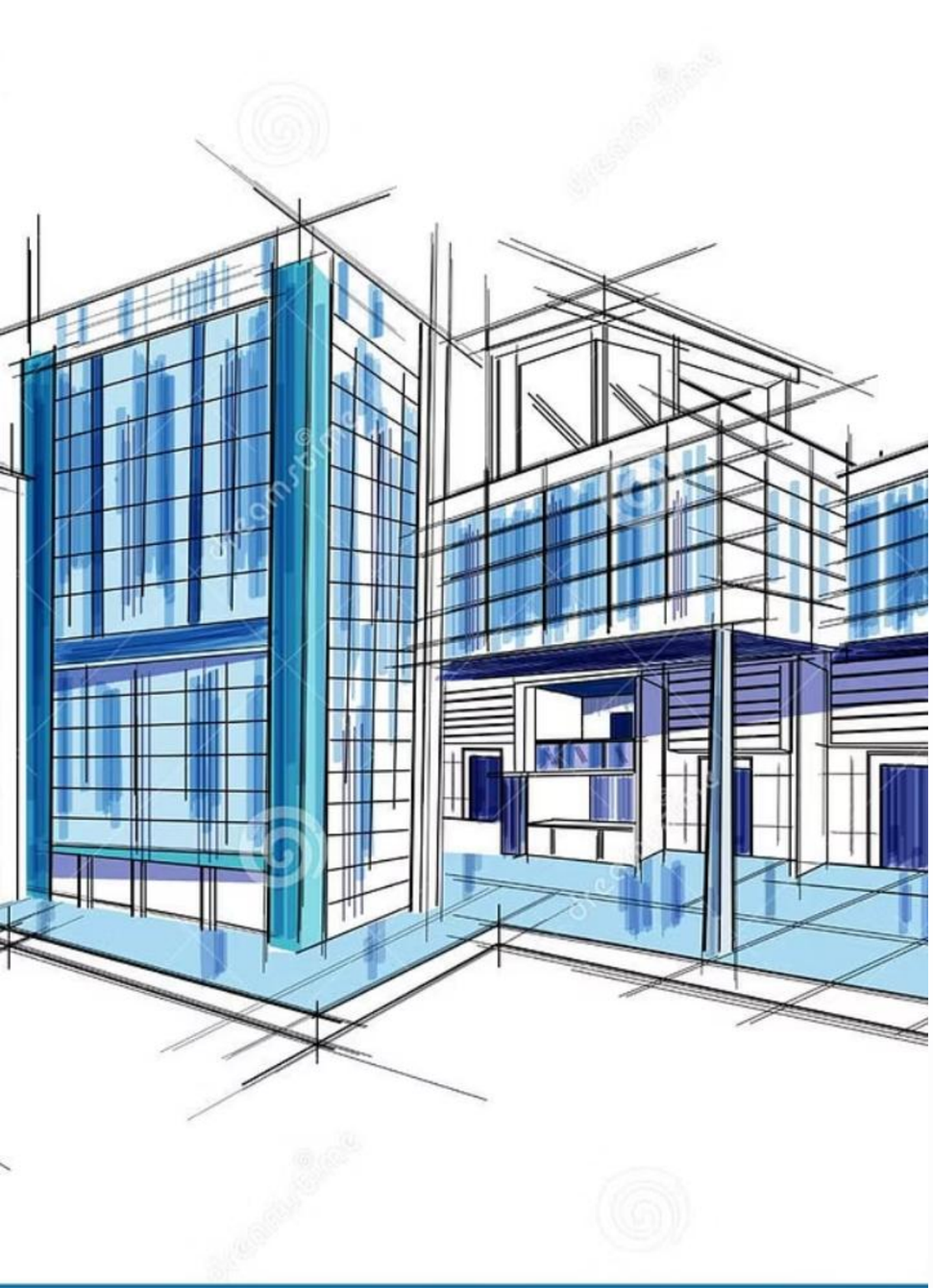
Apply knowledge to accurately read and understand mechanical drawings.

# Key Terminology

| Term | Definition |
| --- | --- |
| Scale | Proportional ratio of a linear dimension of the model to the same feature of the original |

Understanding terminology is essential for correctly interpreting mechanical drawings and specifications in the gas industry.





# Basic Drawing Views

## Three-Dimensional Representation

Buildings are three-dimensional objects, making it impossible for a single view to show an entire building and all necessary details.

## Multiple Perspectives

A set of construction drawings typically includes various views showing the building from different angles to provide complete information.

## Comprehensive Understanding

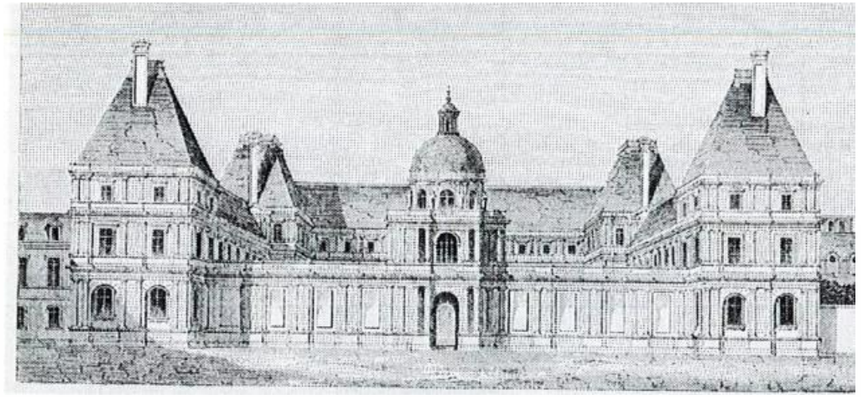
Different views work together to convey all the construction information needed for proper installation and connection.

# Pictorial Drawings

## Easy Comprehension

Pictorial or perspective drawings are easy to understand because they show an object as it appears in real life.

Like photographs, pictorials show the length, width, and height of objects in a single view, giving viewers a quick mental image of an object.



Pictorial drawings are like photographs, showing the object as it appears. They're particularly useful for inexperienced readers of construction prints.

# Uses of Pictorial Drawings

## Architectural Visualization

Architects often use pictorial drawings to show project owners how the final building will look.

## Quick Comprehension

Viewers can quickly understand the object's appearance, even if they are inexperienced in reading construction prints.

## Three-Dimensional View

Shows length, width, and height of objects in a single view, similar to a photograph.

# Orthographic Projections

## Precise Information

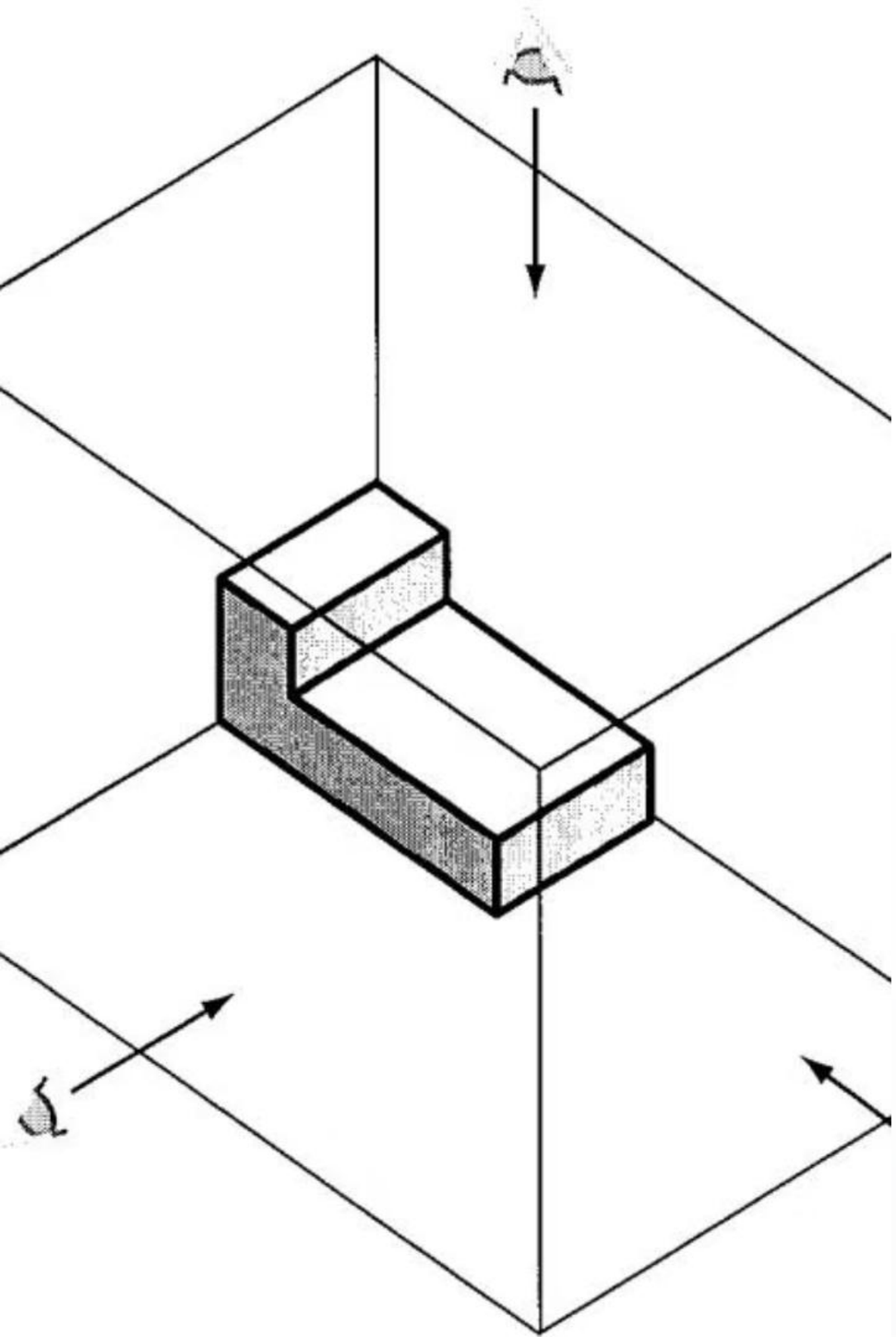
While pictorial drawings give a quick mental image, they aren't ideal for conveying precise information about size and shape.

In pictorial drawings, parts of the object are distorted to create a three-dimensional look, which can affect accuracy.

## Two-Dimensional Views

Orthographic projection shows separate but related two-dimensional views of an object on a single piece of paper.

This method provides the precise information needed to fabricate the object without distortion.



# The Glass Box Concept

## Imagine an Object in a Glass Box

The best way to understand orthographic projection is to imagine an object floating inside a glass box.

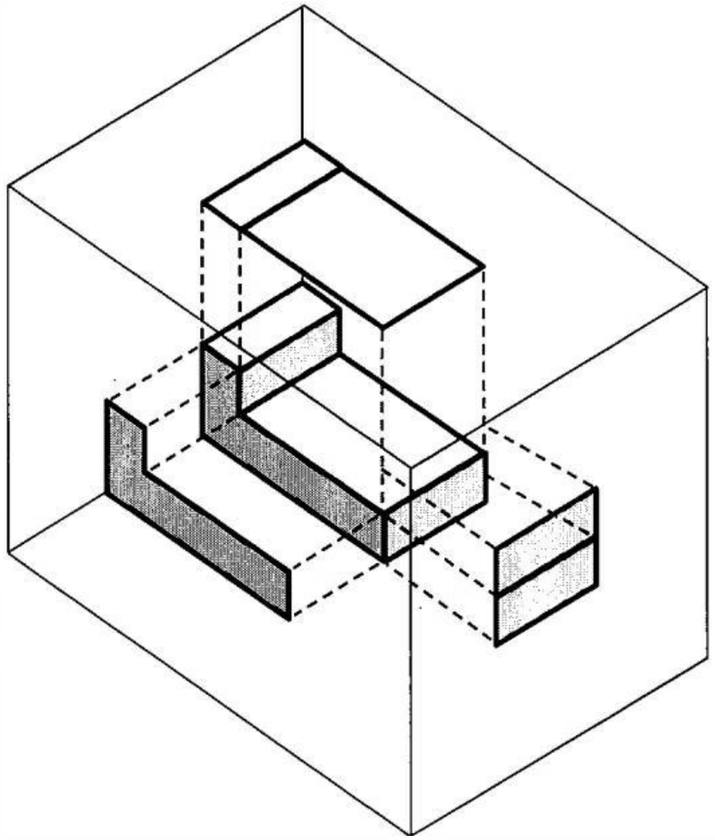
## Draw Views on Each Side

Looking at right angles through each side of the box, you would draw the view of the object on the glass.

## Create Plane Views

Each view through the glass shows only one plane of the object, with all lines straight and parallel.

# Orthographic View Representation



Each side of the glass box shows only one plane of the object and all lines are straight and parallel.

## Square Views

Each view represents what you would see when looking at the object squarely from that direction.

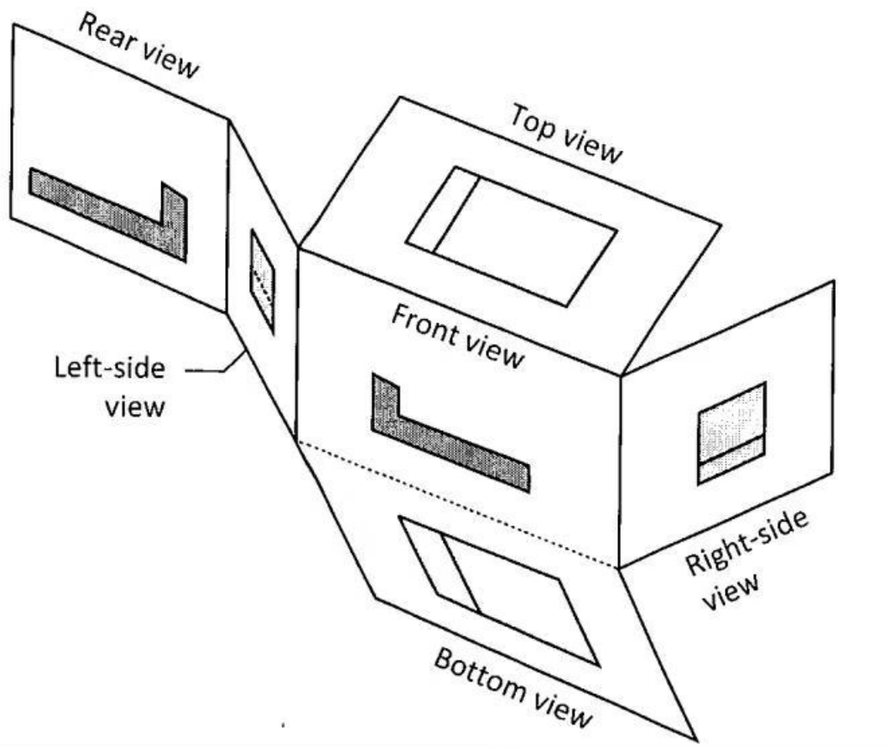
This method eliminates distortion and provides accurate dimensions for each plane of the object.

# Opening the Glass Box

## Unfolding the Views

If you were to open the imaginary glass box, each view would be in the correct position for a true orthographic drawing.

Each view has a name that reflects its position in relation to the other views.




Opening up the imaginary glass box places each view in the correct position for a true orthographic drawing.

# Figure 3-5

# g with the glass box flatte

## Flattening the Glass Box

### Flatten the Box

The next step is to flatten out the imaginary box to create a two-dimensional representation.

### Remove the Box

Finally, remove the box completely to leave only the views of the object.

### Create Standard Projection

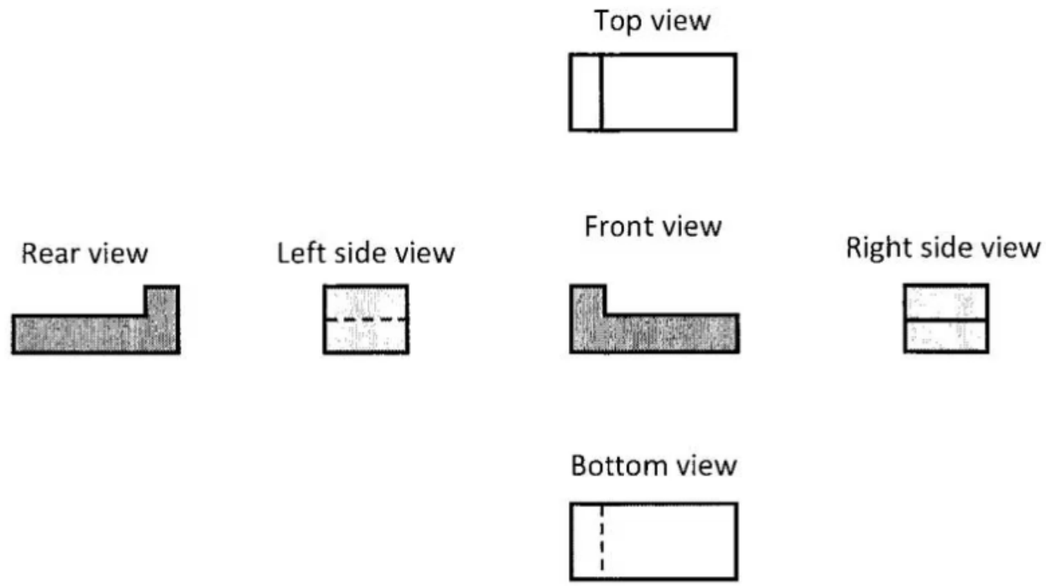
The result is a standard six-view orthographic projection showing all sides of the object.

# Six-View Orthographic Projection

## Complete Representation

A standard six-view orthographic projection shows the front, back, top, bottom, left side, and right side of an object.

This comprehensive set of views provides complete information about the object's dimensions and features from every angle.




Standard six-view orthographic projection showing all sides of an object in a flattened arrangement.

# Practical Orthographic Projections

## Simplified Views

In most cases, it is not necessary to show all six sides of an object.

Most orthographic projections show only the front, top, and right-side views.

**Figure 3-7**
**Typical orthographic projection shows only three views**

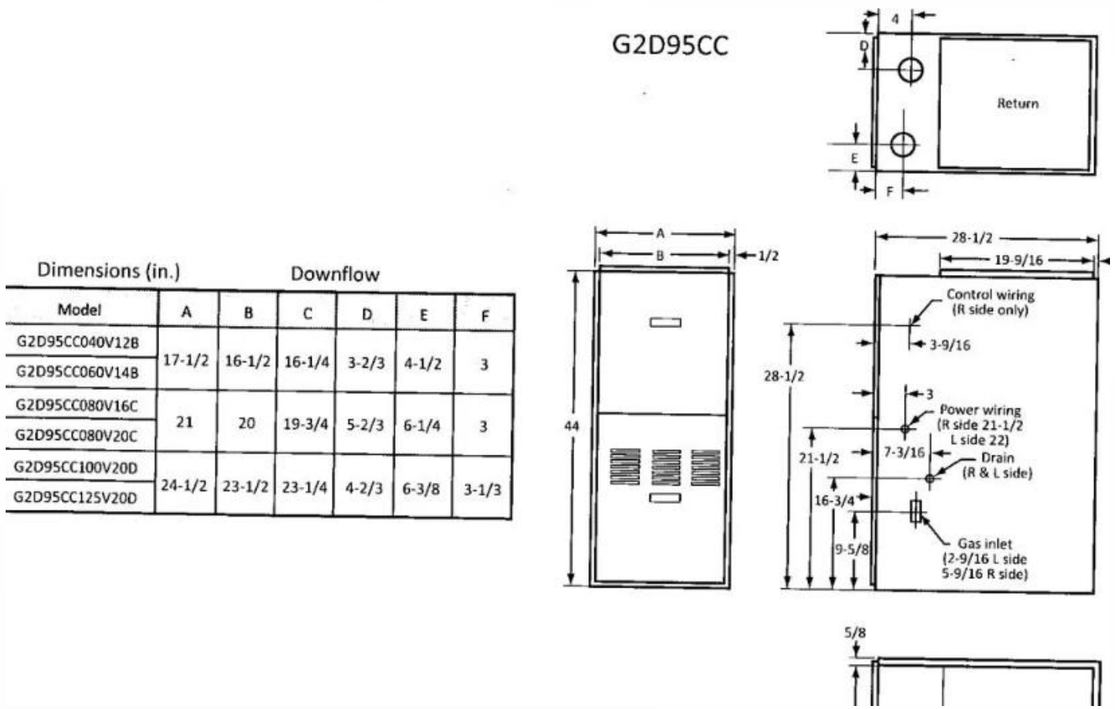
## Essential Information

Designers generally include only as many views as needed to convey the information required to fabricate the object.

# Orthographic Projections in Appliance Specifications

## Practical Applications

One common use of orthographic projection in manufacturer's instructions is to show the dimensions and optional layouts for appliances or components.



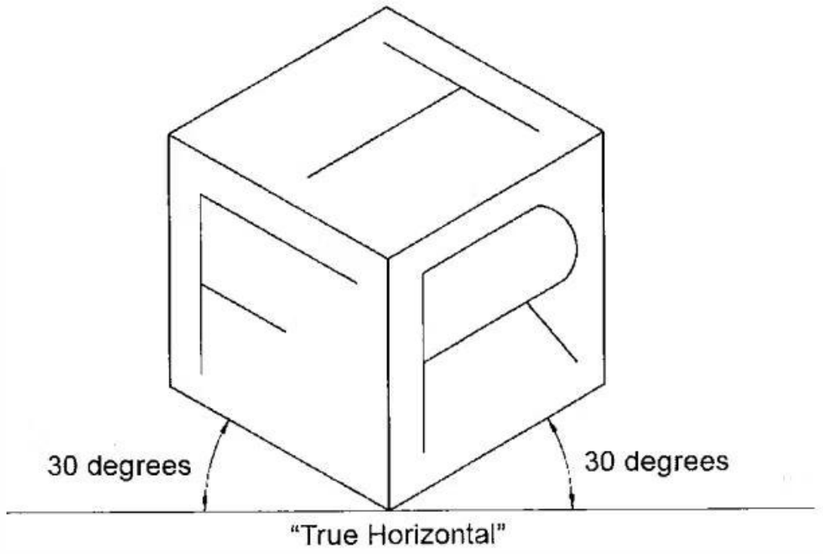

Orthographic projection of an Armstrong gas furnace showing dimensions and layout options.

# Isometric Drawings

## Combining Approaches

An isometric drawing is like a pictorial or perspective drawing, except that its front view is flat like the front view of an orthographic projection.

The receding view is at a 30° angle, creating a three-dimensional appearance while maintaining more accurate proportions.




Isometric drawing showing a three-dimensional view with the front face flat and receding lines at 30° angles.

# Isometric Drawings in Manufacturer's Instructions

## Component Visualization

Manufacturer's instructions often include isometric drawings to show component parts.

## Assembly Guidance

These drawings help technicians understand how parts fit together during installation or repair.

## Three-Dimensional Clarity

Isometric views provide a clear three-dimensional representation while maintaining relatively accurate proportions.

# Types of Drawings

## Architectural

Overall building design and layout

## Structural

Building support elements

## Manufacturer's

Specific equipment details

## Mechanical

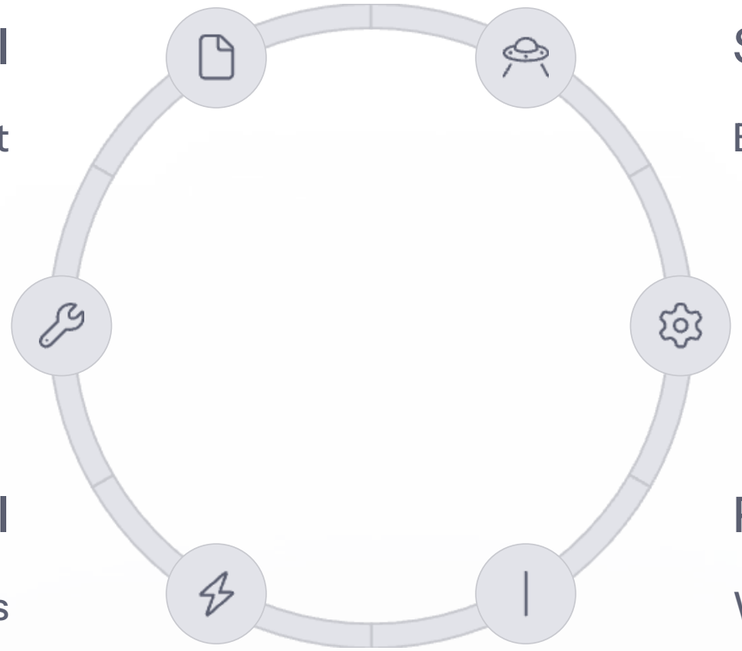
HVAC and equipment systems

## Electrical

Power and lighting systems

## Plumbing

Water and gas distribution

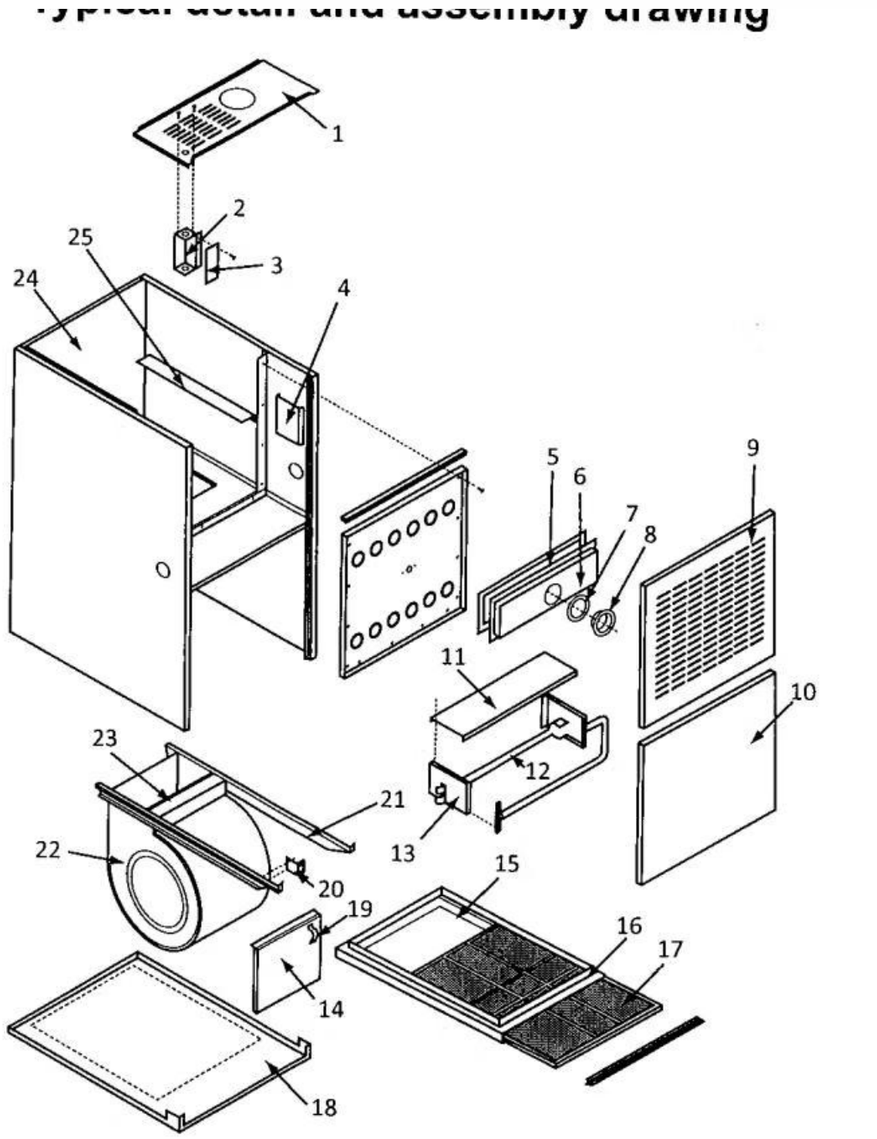


# Detail and Assembly Drawings

## Component Visualization

A detail or assembly drawing is a detailed drawing of the components and hardware of an appliance.

These drawings are particularly useful when you need to disassemble, assemble, or repair an appliance on the job site.



# Detail Drawing Characteristics

## Focused Scope

As the name implies, a detail drawing shows a small part of the entire project in great detail.

## Larger Scale

Often, a larger scale is used to include more detailed information in the drawing.

## Component Clarity

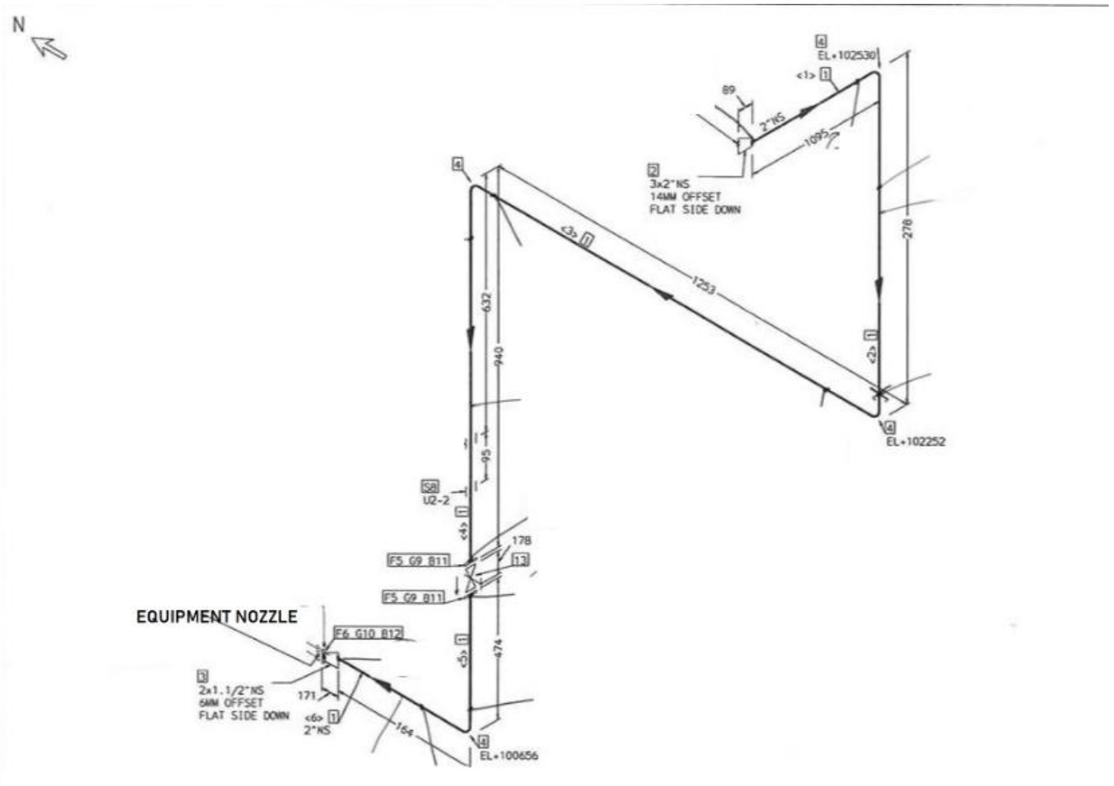
Detail drawings provide clear information about specific parts, making them invaluable for repair and maintenance work.

# Piping Drawings

## Representation Types

Piping drawings can be orthographic or isometric, depending on the level of detail and perspective needed.

The typical isometric drawing displays all the important pieces in symbol form like a schematic.




Piping drawings use standardized symbols to represent valves, fittings, and other components in a clear, consistent manner.

Figure 3-13
Sample of a mechanical drawing

# Mechanical Drawings

## Purpose

The purpose of mechanical drawings is to illustrate the mechanical systems in a building.

## Creation Timeline

They are drawn during the design of the building and reviewed during construction.

## Content

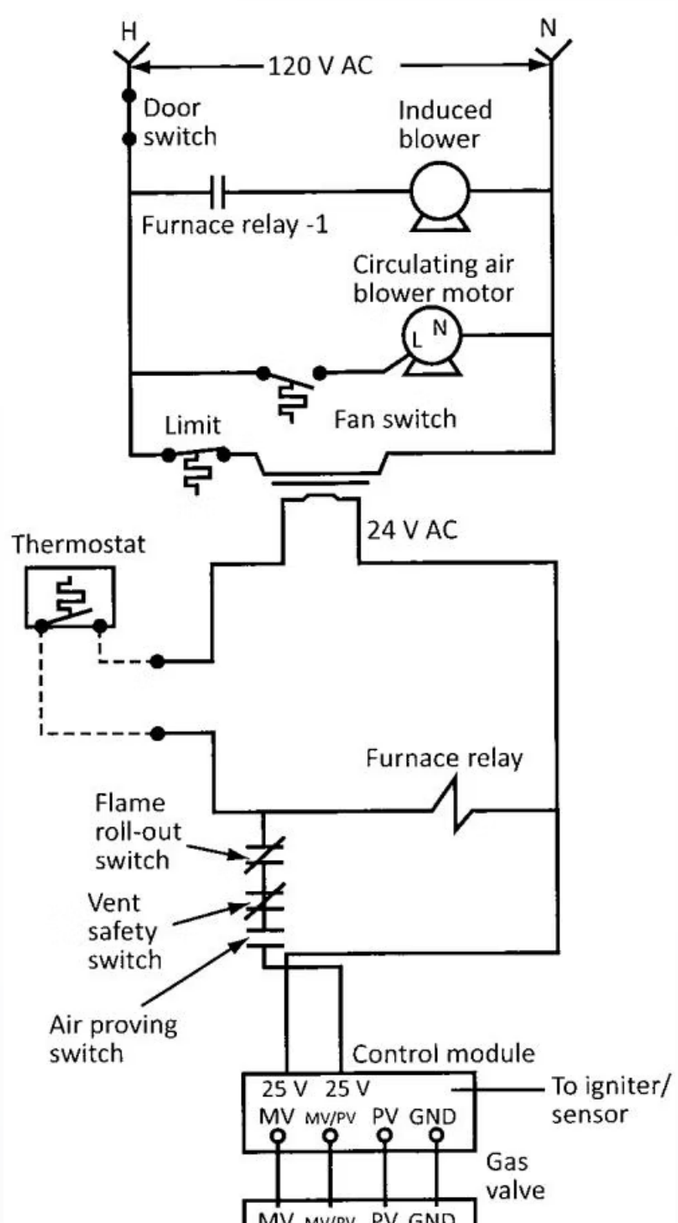
Typically includes building address, location of mechanical equipment, ventilation systems, electric panel locations, ductwork location, and sizes.

# Schematic Diagrams

## Function Over Form

The schematic diagram facilitates the tracing of hydraulic, pneumatic, or electrical lines and the components of each.

It shows the relationship between the various parts of a system, not the actual size, shape, or location of the components or devices.



# Schematic Diagram Focus

## Connections

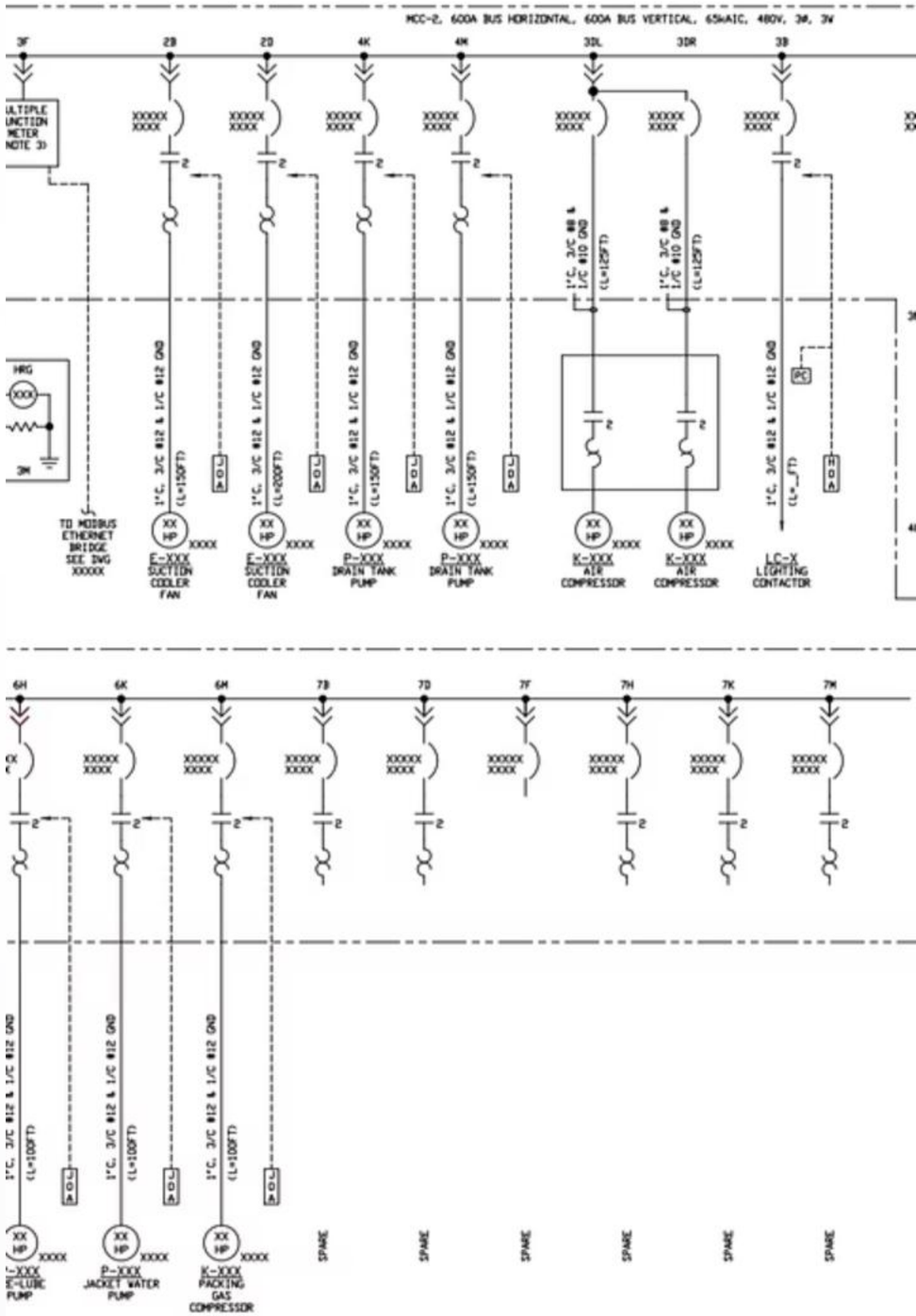
Schematics show how components connect to each other within a system.

## Functions

They illustrate the functional relationship between components rather than their physical arrangement.

## Flow

Schematics demonstrate how energy, signals, or materials flow through the system.

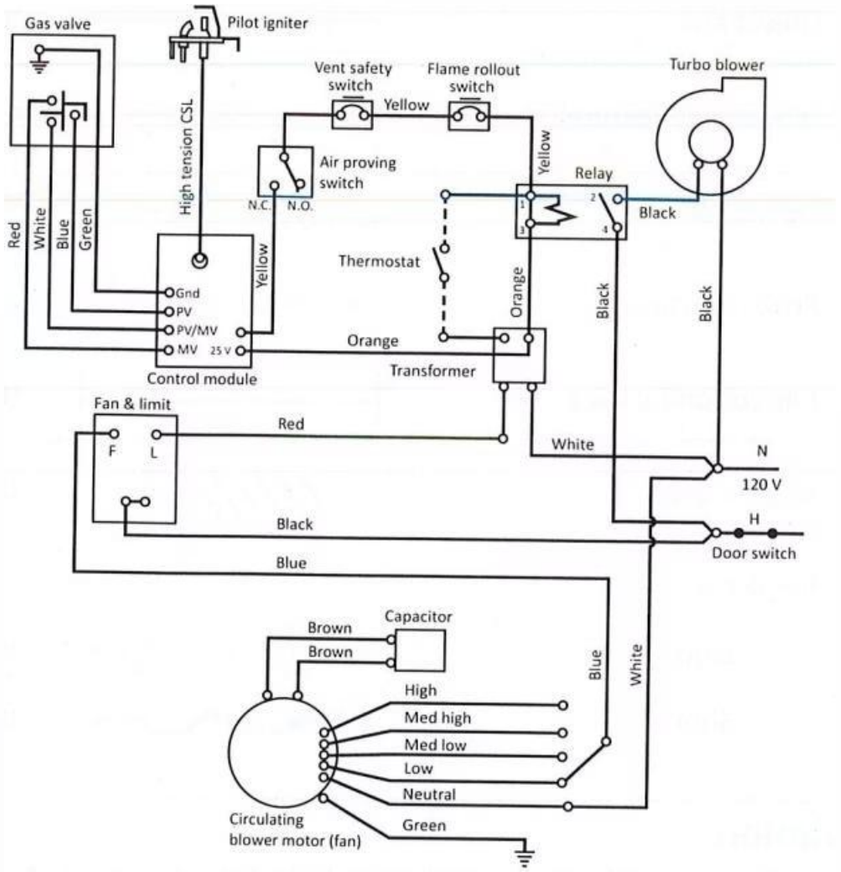


# Wiring Diagrams

## Physical Representation

Unlike schematic diagrams, wiring diagrams show how and where the wires are connected and how they run between devices.

Wiring diagrams are very useful for the initial wiring of a circuit and for tracing wires when troubleshooting.




Wiring diagram of an electrical circuit showing the physical arrangement of connections.

# Wiring Diagram Conventions

## Solid Lines

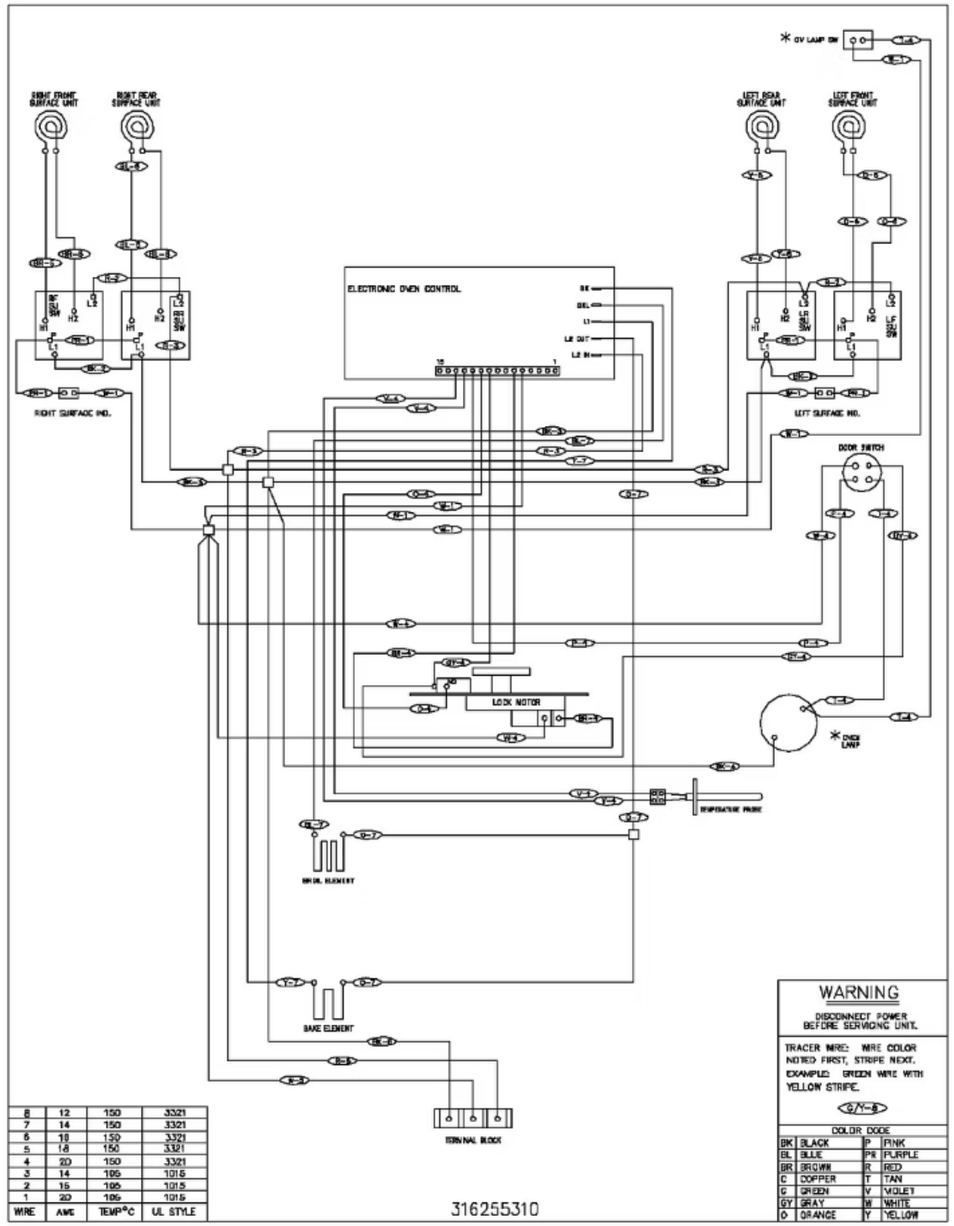
Solid lines typically represent conductors that the manufacturer has wired in the factory.

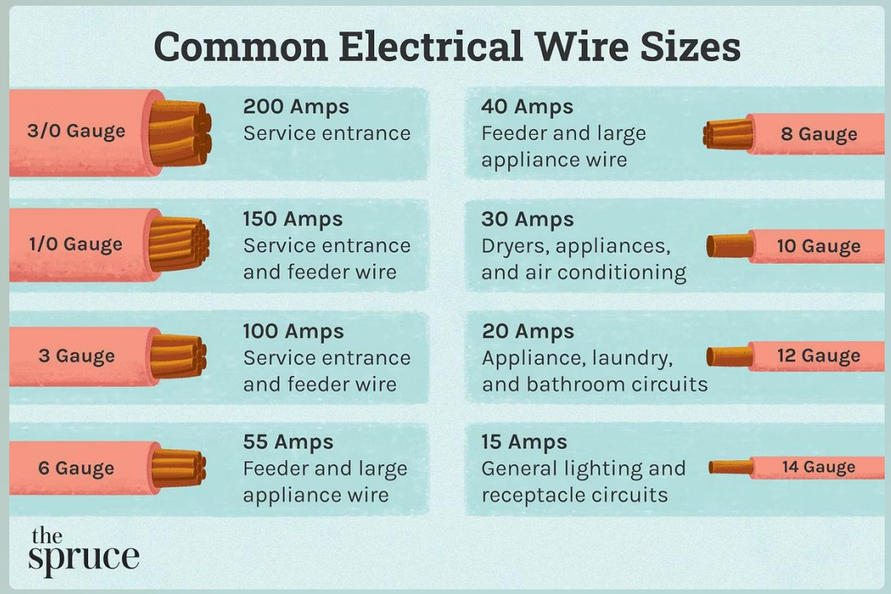
## Broken or Dotted Lines

Broken or dotted lines represent wiring that will be applied in the field by the technician.

## Common Placement

Wiring diagrams are commonly found on the rear panel covers of major gas and propane appliances.






# Wiring Diagram Schedules

## Definition

Wiring diagrams often come with a schedule, which is usually a table that lists important details.

## Color Information

Schedules typically include color codes for different wires in the system.

## Terminal Locations

They provide information about where wires connect to terminals in the system.

## Voltage Specifications

Schedules list the expected voltage at various points in the circuit.

# Lines and Symbols

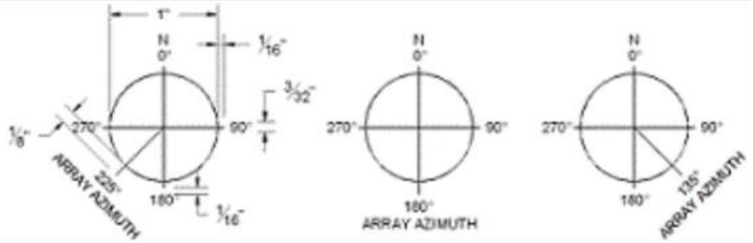
## Visual Language

Lines and symbols are the language of the draftsperson.

In gas or hydronic systems, they help visually represent pipes, fittings, valves, and components.

## System Visualization

When drawn together in their respective positions, they clearly illustrate a piping system and explain a great deal of how it operates.

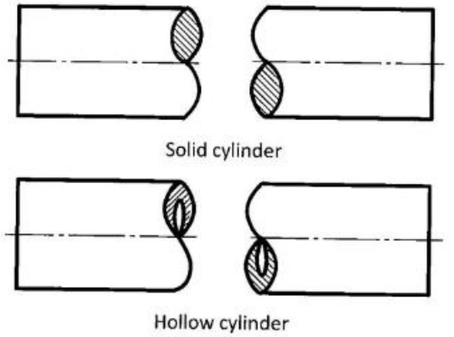
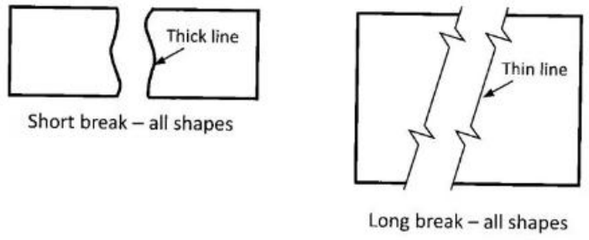
| | | |
|---|---|---|
| | HIDDEN LT | |
| 01 42 00-015 LINE | new line; medium line<br><br>014200-015 NEW LINE<br>use CONTINUOUS LT | |
| 01 42 00-016 LINE | property line; wide line, 5 mm (3/16") dash, 3 mm (1/8") space<br><br>014200-016 PROP LINE | |
| 01 42 00-084 LINE | resist the passage of smoke = RPS; wide line, 3/32" text<br><br>014200-084 RESIST PASSAGE OF SMK | RPS |
| 01 42 00-017 LINE | smoke barrier line; fine line, 2.5 mm (3/32") text, 14 mm (9/16") repeat<br><br>014200-017 SMK BARRIER LINE | S |
| 01 42 00-082 REF | azimuth indicator, 1 inch diameter, medium line, 2.5 mm (3/32") text<br><br>014200-082-REF AZIMUTH INDICATOR |  |
| 01 42 00-018 REF | break, round (user defines size)<br><br>014200-018-REF BREAK RND | |
| | break, straight (see section indicators, building, with break standards) | |

# Line Types and Meanings

## Information Precision

Lines on technical drawings provide exact information concerning the shape of an object and how it is connected to other objects and various circuits.

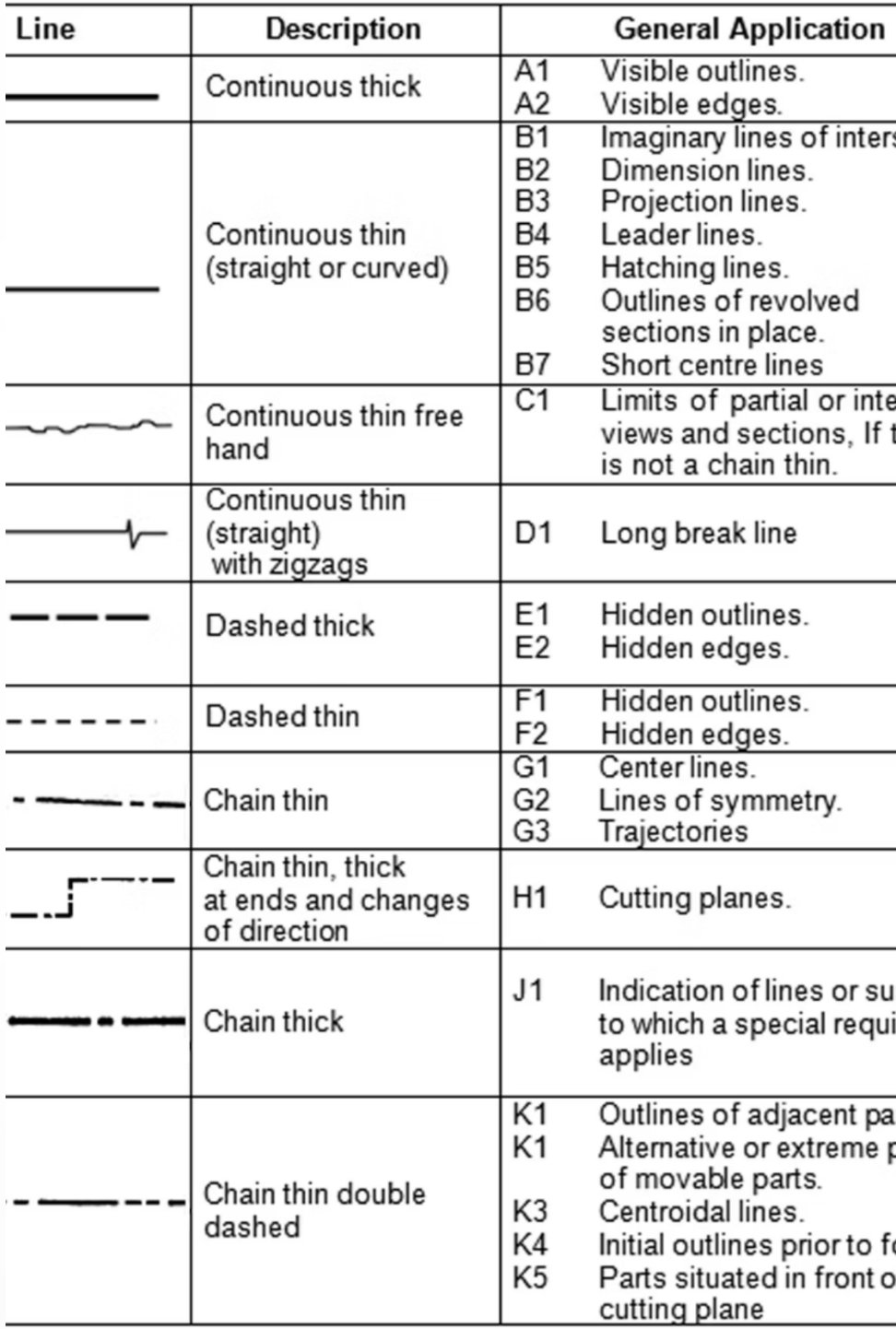
A variety of lines help convey different meanings, with Canadian standards defining line thickness as thick or thin.

| Type | Description |
|---|---|
| | **Figure 3-18**<br>**Section lines for hollow and solid cylinders**<br>  <br> |
| Break lines | Help shorten the view of long uniform sections Figure 3-19 shows the two types of break lines used on technical drawings.<br>**Figure 3-19**<br>**Break lines for short and long sections**<br>  <br> |

Thick lines are at least twice as thick as thin lines, creating visual hierarchy in the drawing.

# Common Line Types

| Line Type | Description |
| --- | --- |
| Object line | Thick lines that trace the visible outline of an object |
| Hidden line | Thin, equally spaced, broken lines that show surfaces and features hidden in the chosen views |
| Centreline | Thin, broken lines, with long and short lines spaced alternately that indicate the exact centre of an object |
| Extension line | Thin lines that do not touch the object lines and extend them out for dimensioning |
| Dimension line | Thin lines with arrowheads that touch extension lines, giving measured dimensions |



| Line | Description | General Application | |
| --- | --- | --- | --- |
| | Continuous thick | A1<br>A2 | Visible outlines.<br>Visible edges. |
| | Continuous thin (straight or curved) | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br><br>B7 | Imaginary lines of inters<br>Dimension lines.<br>Projection lines.<br>Leader lines.<br>Hatching lines.<br>Outlines of revolved sections in place.<br>Short centre lines |
| | Continuous thin free hand | C1 | Limits of partial or inte views and sections, If t is not a chain thin. |
| | Continuous thin (straight) with zigzags | D1 | Long break line |
| | Dashed thick | E1<br>E2 | Hidden outlines.<br>Hidden edges. |
| | Dashed thin | F1<br>F2 | Hidden outlines.<br>Hidden edges. |
| | Chain thin | G1<br>G2<br>G3 | Center lines.<br>Lines of symmetry.<br>Trajectories |
| | Chain thin, thick at ends and changes of direction | H1 | Cutting planes. |
| | Chain thick | J1 | Indication of lines or su to which a special requi applies |
| | Chain thin double dashed | K1<br>K1<br><br>K3<br>K4<br>K5 | Outlines of adjacent pa<br>Alternative or extreme p of movable parts.<br>Centroidal lines.<br>Initial outlines prior to fo<br>Parts situated in front o cutting plane |

# Piping Symbols and Lines

## Standardized Shorthand

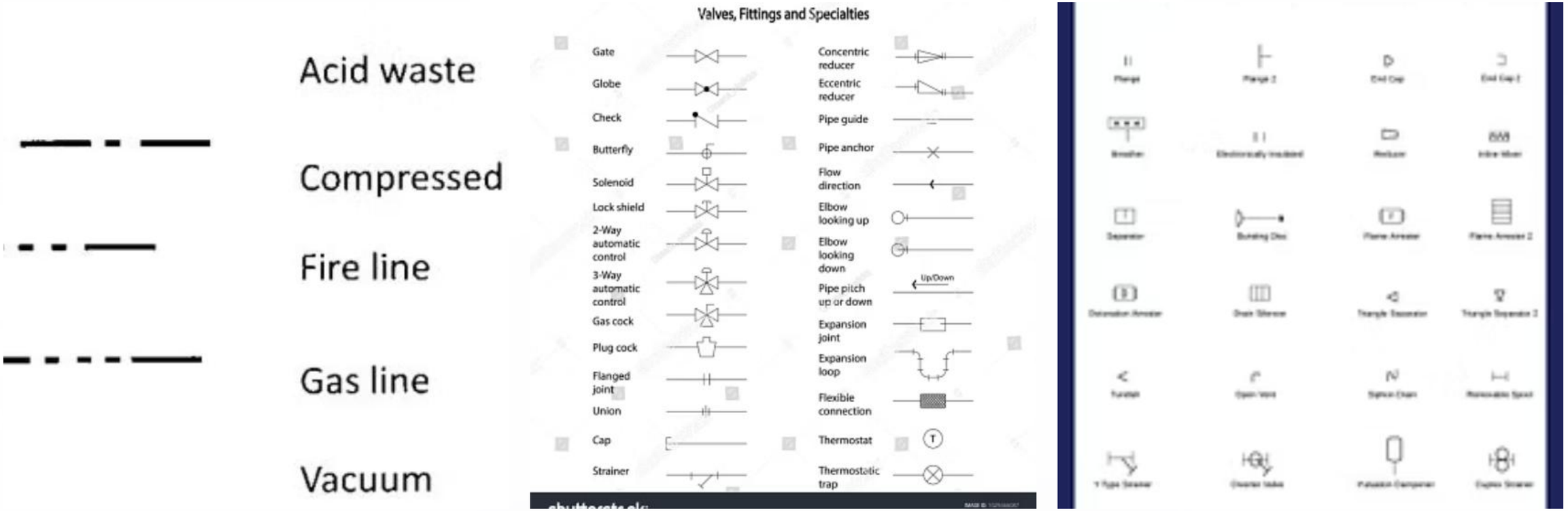
Symbols are the shorthand signs used on drawings. They are for the most part international, but some countries have different symbols.

Organizations like ISO, CSA Group, and ANSI publish tables of symbols for welding, piping, surface texture, and electrical elements.

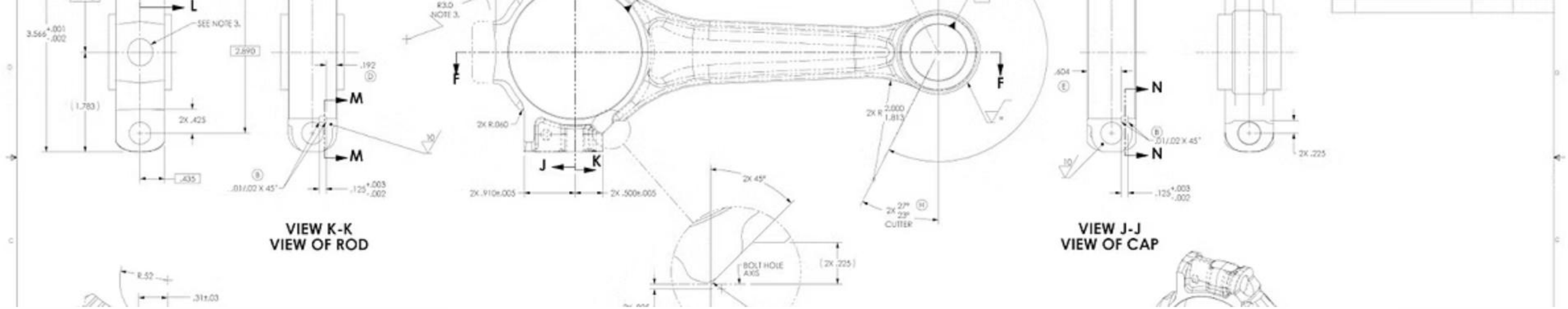
**Figure 3-21**
**Various piping line symbols**

Common piping fitting symbols used in mechanical drawings.

# Common Fitting Symbols




Piping installation plans contain special lines to distinguish various types of pipes, with different symbols representing elbows, tees, wyes, crosses, caps, plugs, and reducing couplings in both single-line and double-line formats.




# Supplements to Mechanical Drawings

## Specifications Book

Written description of future work

## Contract Document

Integral part of the agreement

## Special Blocks

Title block, revision block, materials list

# Specifications

## Variable Scope

A specification normally accompanies the construction prints and can vary considerably in length depending on the size and complexity of the project.

On smaller jobs, the specifications or "specs" may consist simply of a list of materials written on the same page as the drawings.

## Comprehensive Documentation

On large projects, the specifications are printed in book or manual form, often spanning several hundred pages.

These comprehensive specs cover every aspect of the job from the initial bidding process to the final payment.

# Precedence of Specifications

## Contractual Importance

The specification is an integral part of the contract documents and is generally considered the most important document after the actual written agreement.

## Conflict Resolution

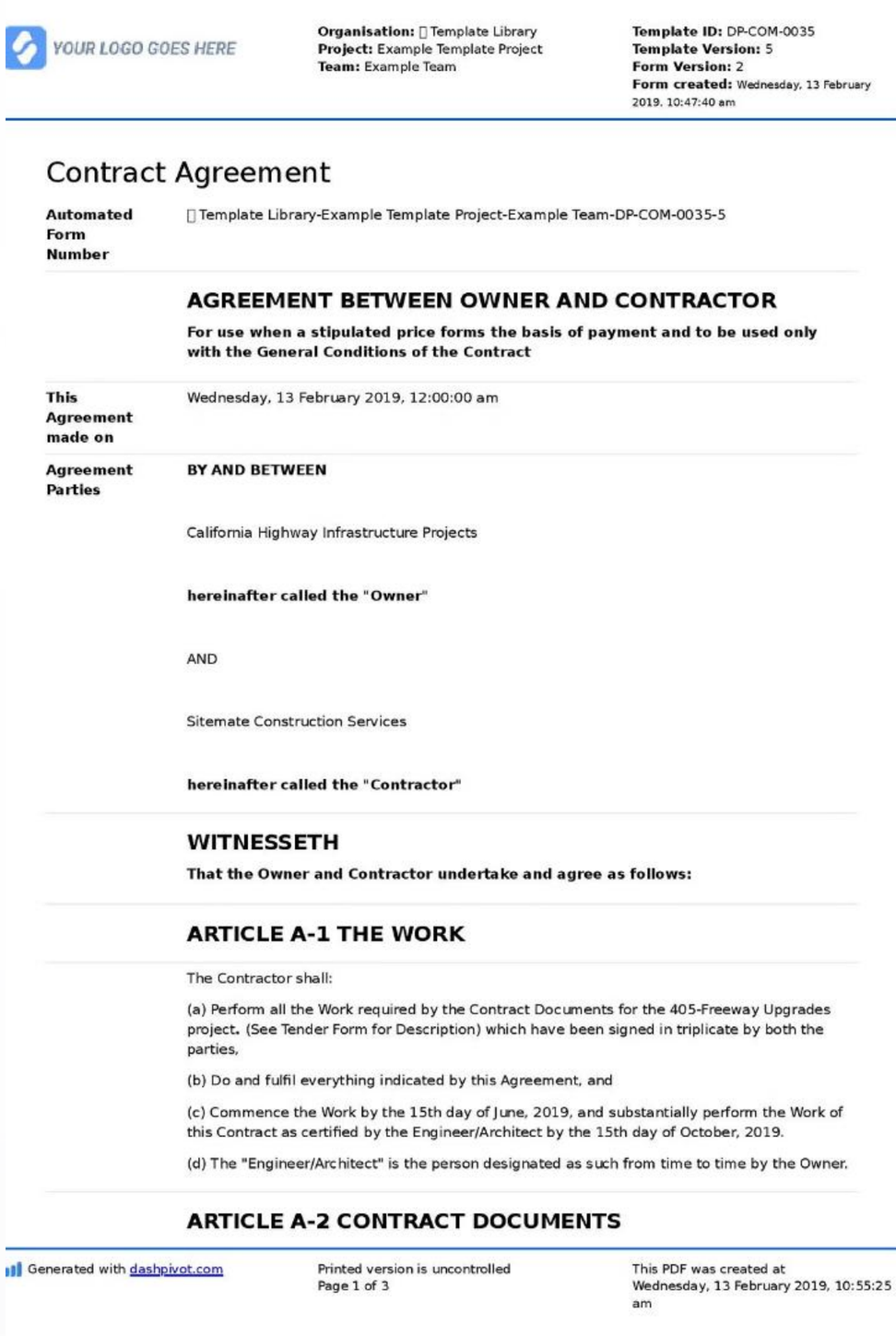
If there is any disagreement between the specification and a drawing, the information in the specification is usually taken to be correct.

## Final Decisions

The reason is that specifications usually come last in preparation and reflect final decisions.

## Legal Weight

Written instructions also carry more weight in a court of law.



YOUR LOGO GOES HERE

**Organisation:** Template Library
**Project:** Example Template Project
**Team:** Example Team

**Template ID:** DP-COM-0035
**Template Version:** 5
**Form Version:** 2
**Form created:** Wednesday, 13 February 2019, 10:47:40 am

Contract Agreement

**Automated Form Number** Template Library-Example Template Project-Example Team-DP-COM-0035-5

**AGREEMENT BETWEEN OWNER AND CONTRACTOR**

**For use when a stipulated price forms the basis of payment and to be used only with the General Conditions of the Contract**

**This Agreement made on** Wednesday, 13 February 2019, 12:00:00 am

**Agreement Parties** **BY AND BETWEEN**

California Highway Infrastructure Projects

**hereinafter called the "Owner"**

AND

Sitemate Construction Services

**hereinafter called the "Contractor"**

**WITNESSETH**

**That the Owner and Contractor undertake and agree as follows:**

**ARTICLE A-1 THE WORK**

The Contractor shall:

(a) Perform all the Work required by the Contract Documents for the 405-Freeway Upgrades project. (See Tender Form for Description) which have been signed in triplicate by both the parties,

(b) Do and fulfil everything indicated by this Agreement, and

(c) Commence the Work by the 15th day of June, 2019, and substantially perform the Work of this Contract as certified by the Engineer/Architect by the 15th day of October, 2019.

(d) The "Engineer/Architect" is the person designated as such from time to time by the Owner.

**ARTICLE A-2 CONTRACT DOCUMENTS**

# Handling Discrepancies

## Identify the Issue

Recognize when there is a discrepancy between specifications and drawings.

## Report to Architect

If a discrepancy is found, it should be reported to the architect.

## Seek Confirmation

The architect should confirm the correct information to resolve the discrepancy.

## Document Resolution

Ensure the resolution is documented for future reference.

# The Scale

## Importance

The scale is very important, although it does not occupy its own block on drawings.

It makes it possible to describe details of large and small machines or components on standard sized paper.

## Determining Factors

The size and complexity of the machine determine the scale used in the drawing.

The first figure of a scale designation refers to the dimensions used to draw the object, while the second number refers to the actual size of the object.

# Scale Types

| Scale Type | Ratio Example | Description |
| --- | --- | --- |
| Actual scale | 1:1 | Drawing is actual size |
| Reduced scale | 1:10 | One unit on the print represents 10 units in the object (drawing is 10 times smaller) |
| Enlarged scale | 10:1 | Ten units on the print equals 1 unit of the object (drawing is 10 times larger) |
| Imperial measurement | 1/8" = 1'0" | Scale described in imperial measurements |

Converting scales up or down (shown as percentage % factor)

| | | Desired Scale | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | 1/10 | 1/20 | 1/50 | 1/00 | 1/200 | 1/500 | 1/1000 | 1/1250 |
| | 1/10 | | 200% | 500% | 1000% | 2000% | 5000% | 10000% | 12500% |
| | 1/20 | 50% | | 250% | 500% | 1000% | 2500% | 5000% | 6250% |
| | 1/50 | 20% | 40% | | 200% | 400% | 1000% | 2000% | 2500% |
| | 1/100 | 10% | 20% | 50% | | 200% | 500% | 1000% | 1250% |
| | 1/200 | 5% | 10% | 25% | 50% | | 250% | 500% | 625% |
| | 1/500 | 2% | 4% | 10% | 20% | 40% | | 200% | 250% |
| | 1/1000 | 1% | 2% | 5% | 10% | 20% | 50% | | 125% |
| | 1/1250 | 0.8% | 1.6% | 4% | 8% | 16% | 40% | 80% | |
| | | Divide the desired scale by the current scale | | | | | | | |

# ut Page Tables and Rev

| TABLE OF CONTENTS | | |
|---|---|---|
| Label | Title | Desc |
| | | |
| A-2 | FIRST FLOOR PLAN | |
| A-3 | 2ND FLOOR PLAN | |
| A-4 | EXTERIOR ELEVATIONS | |
| A-5 | EXTERIOR ELEVATIONS & ROOF PLAN | |
| A-6 | BUILDING CROSS SECTIONS | |
| A-7 | BUILDING CROSS SECTIONS | |
| A-8 | BUILDING CROSS SECTIONS | |
| A-1 | FOUNDATION PLAN | |
| A-9 | FIRST FLOOR FRAMING | |
| A-10 | 2ND FLOOR FRAMING & DETAIL | |
| A-11 | ROOF FRAMING PLAN | |
| A-11 | ELECTRICAL & LIGHTING PLANS | |
| A-12 | KITCHEN FLOOR PLAN & ELEVATIONS | |
| A-13 | KITCHEN ELEVATIONS | |

# Revision Block

## Placement

The revision block may be placed either in the lower left- or upper right-hand corner of the print.

## Purpose

The purpose of this block is to list any and all revisions made to the drawing after the initial drafting of the print.

## Change Tracking

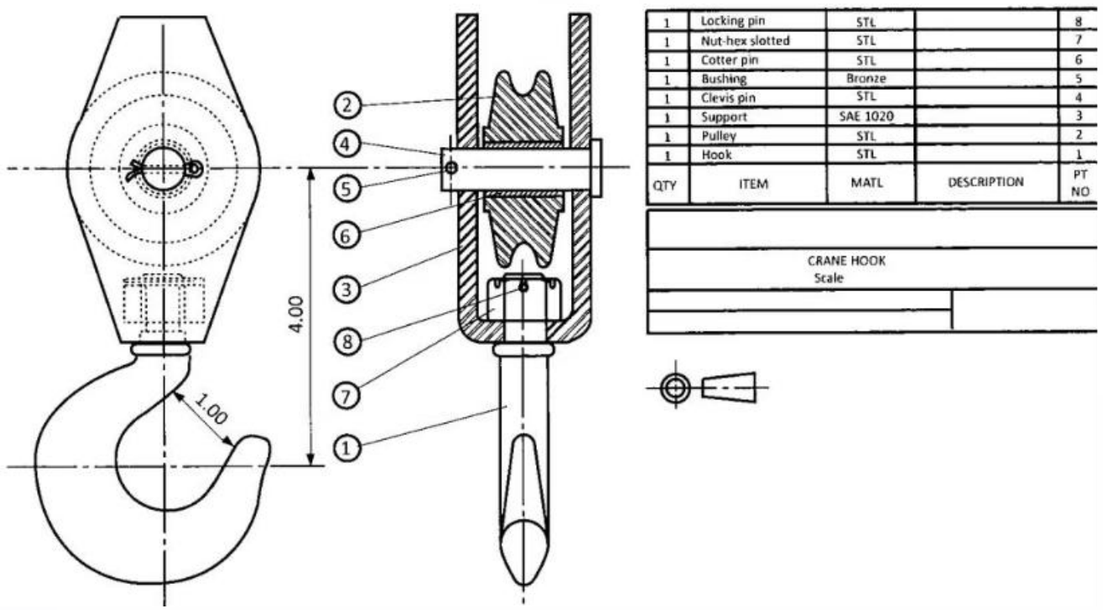
This ensures that all modifications to the original design are documented and traceable.

# Materials Block

## Location and Purpose

The materials block is generally found just above the title block.

It may also be called the bill of materials and provides a complete list of parts for that print or page.




| QTY | ITEM | MATL | DESCRIPTION | PT NO |
|---|---|---|---|---|
| 1 | Locking pin | STL | | 8 |
| 1 | Nut-hex slotted | STL | | 7 |
| 1 | Cotter pin | STL | | 6 |
| 1 | Bushing | Bronze | | 5 |
| 1 | Clevis pin | STL | | 4 |
| 1 | Support | SAE 1020 | | 3 |
| 1 | Pulley | STL | | 2 |
| 1 | Hook | STL | | 1 |

CRANE HOOK
Scale

A materials block listing parts and components needed for the project.

# Materials List Content

## Part Identification

All parts in a materials list are identified by their part or stock number.

## Size Specifications

The materials list provides the number and size of each part.

## Fastener Details

Includes all fasteners such as bolts, washers, and nuts.

## Comprehensive Inventory

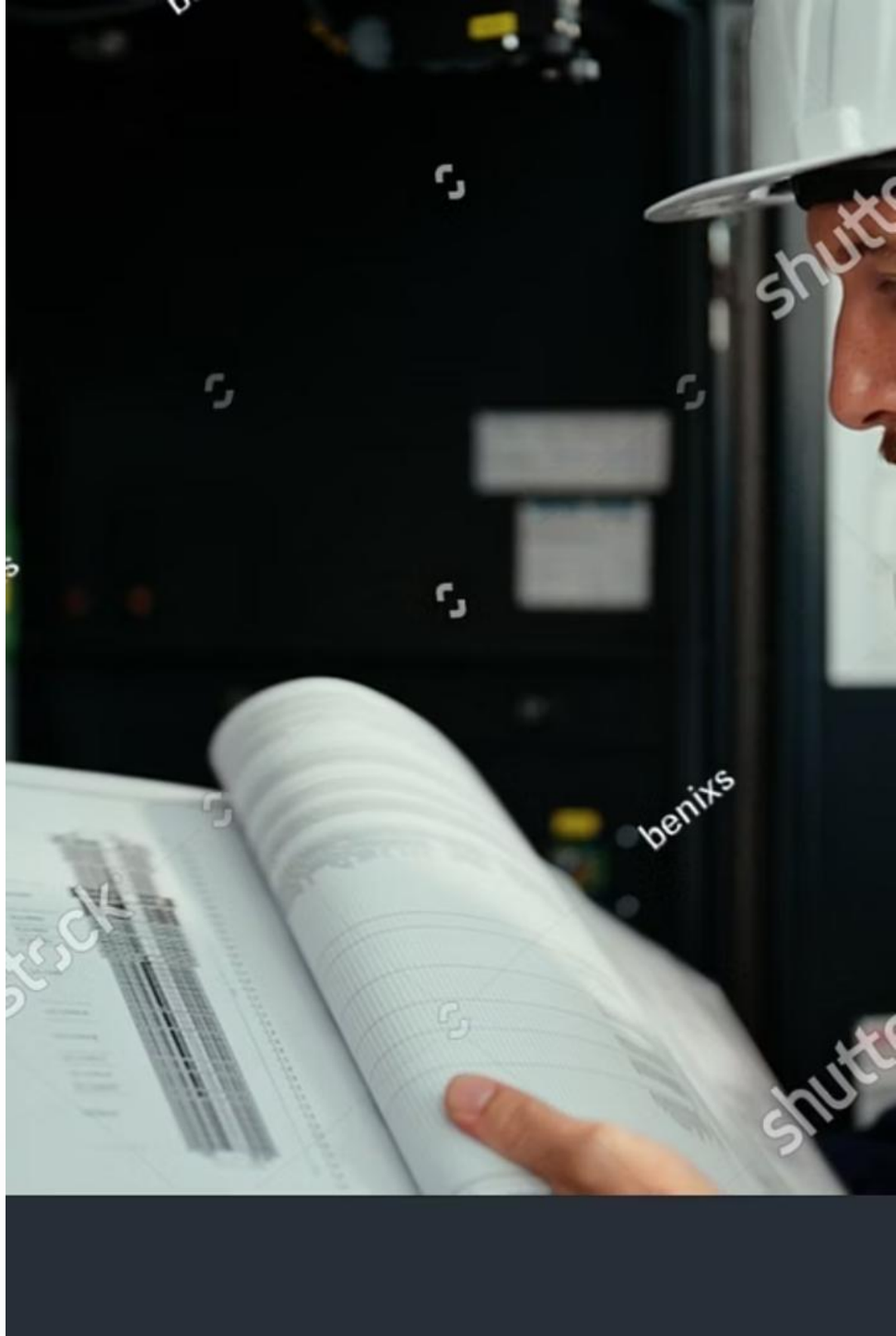
Provides a complete list of parts for that specific print or page.

er: 20-0001
ne: EveryRoad GPS, Shippable, US Model 300
on: B
te: 24-Jul-10

| 8 | Part Number | Part Name | Revision | Quantity | Unit of Measure | Procurement Type | Reference Designators | BOM Notes |
|---|---|---|---|---|---|---|---|---|
| | 20-0002 | EveryRoad GPS Car Navigation Unit - Model 300 | B | 1 | each | MTS | | Base Product C |
| | 20-0003 | EveryRoad, Front Bezel Assembly | A | 1 | each | OTS | | |
| | 40-0011 | LCD | A | 1 | each | OTS | | |
| | 50-0012 | EveryRoad, Front Bezel | B | 1 | each | MTS | | |
| | 50-0080 | Gasket, Screen, 3.5in | A | 1 | each | MTS | | |
| | 20-0004 | EveryRoad, Rear Assembly | B | 1 | each | MTS | | |
| | 20-0015 | EveryRoad, PCBA, Model 300 | B | 1 | each | MTS | | |
| | 40-0035 | EveryRoad, Circuit Board | A | 1 | each | MTS | | |
| | 40-0038 | GPS Micro controller | A | 1 | each | OTS | U2 | |
| | 40-0039 | USB Connector | A | 1 | each | OTS | J4 | |
| | 40-0041 | 0.1uF Ceramic Chip Capacitor | A | 5 | each | OTS | C15, C6, C10-12 | |
| | 40-0042 | 10k Resistor | A | 8 | each | OTS | R14, R16, R42-R47 | |
| | 40-0043 | 1k Resistor | A | 4 | each | OTS | R25, R38, R31, R32 | |
| | 40-0044 | 1.0uF Ceramic Capacitor, 1206 | A | 1 | each | OTS | C3 | |
| | 40-0045 | Low-dropout 5.0V 100mA Voltage Regulator | A | 1 | each | OTS | VR1 | |
| | 40-0046 | 100ohm Resistor | A | 1 | each | OTS | R44 | |
| | 40-0047 | 51k Resistor | A | 1 | each | OTS | R4 | |
| | 40-0048 | 470k Resistor | A | 2 | each | OTS | R8, R13 | |
| | 40-0049 | 500mW NPN Transistor | A | 2 | each | OTS | Q5, Q9 | |
| | 40-0050 | Small-signal PNP Transistor | A | 2 | each | OTS | Q2, Q4 | |
| | 40-0051 | 470 ohm Resistor | A | 1 | each | OTS | R15 | |
| | 40-0052 | Tantalum Capacitor 10uF@16V,B pkg | A | 1 | each | OTS | C9 | |
| | 40-0053 | Tantalum Capacitor 4.7uF@4V,A pkg | A | 3 | each | OTS | C1, C4, C8 | |
| | 40-0054 | Voltage Detector CMOS 4.3V SOT23 | A | 1 | each | OTS | VD1 | |
| | 40-0055 | 220k Resistor | A | 1 | each | OTS | R40 | |
| | 40-0056 | 1M Resistor | A | 2 | each | OTS | R2, R9 | |
| | 40-0057 | 0.01uF Ceramic Chip Capacitor, 0603 | A | 2 | each | OTS | C5, C7 | |
| | 40-0058 | 47 ohm Resistor | A | 2 | each | OTS | R3, R17 | |
| | 40-0059 | Small-single NPN Transistor | A | 2 | each | OTS | Q1, Q8 | |
| | 40-0061 | N-Chn Enhan-Md MOSFET | A | 1 | each | OTS | Q6 | |
| | 40-0062 | 3k Resistor | A | 1 | each | OTS | R29 | |
| | 40-0063 | Exclusive Or Gate single | A | 1 | each | OTS | U1 | |
| | 40-0064 | Speaker w/drive circuit 3-15volts | A | 1 | each | OTS | P1 | |
| | 40-0066 | Signal Diode | A | 2 | each | OTS | D8, D10 | |
| | 40-0067 | 2M Resistor | A | 2 | each | OTS | R7, R30 | |
| | 40-0068 | P-Chan MOSFET SOT-223 | A | 1 | each | OTS | Q12 | |
| | 40-0069 | HE 2 Channel solid state relay (B form) | A | 1 | each | OTS | RY1 | |
| | 40-0070 | Schottky Diode, 320mV@1mA | A | 2 | each | OTS | D1,D2 | |
| | 40-0071 | Millmax 0666 Socket for 0.020 pins | A | 2 | each | OTS | J1 ,J3 | |
| | 40-0072 | 2.7k Resistor | A | 2 | each | OTS | R41, R42 | |
| | 40-0073 | 4.0 MHz Fixed oscillator | A | 1 | each | OTS | X1 | |
| | 40-0074 | Miniature Pushbutton Switch, Right Angle | A | 1 | each | OTS | SW1 | |
| | 40-0075 | Single Logic Level P-Channel FET | A | 1 | each | OTS | Q3 | |
| | 40-0076 | Red/Green SM LED | A | 1 | each | OTS | LD1 | |
| | 40-0077 | Molex 4-pin 0.079 RA Header | A | 1 | each | OTS | J2 | |
| | 40-0078 | IR 40Khz Integrated Receiver Siemen | A | 2 | each | OTS | IR1, IR3 | |
| | 50-0016 | EveryRoad, Rear Panel | B | 1 | each | MTS | | |
| | 50-0089 | Screw, M2 x 5, ST, PH, Torx | A | 4 | each | OTS | | Torx Drive Scre |
| | 50-0010 | Screw, M3 x 6, ST, PH, Torx | A | 4 | each | OTS | | |
| | 50-0018 | EveryRoad Model 300 Safety Label | A | 1 | each | MTS | | Label has US ar |
| | 20-0005 | Package Documentation | A | 1 | each | OTS | | |
| | 90-0006 | Manual - Model 300/500 | B | 1 | each | MTS | | |
| | 90-0007 | Warranty Card | A | 1 | each | OTS | | |
| | 30-0085 | Packaging | A | 1 | each | MTS | | |
| | 50-0087 | EveryRoad Model 300 US Boxed Product Label | A | 1 | each | MTS | | Barcode label |
| | 50-0088 | Box with EveryRoad Logo, 5 in x 5 in x 5 in | B | 1 | each | MTS | | Box logo |
| | 40-0009 | Power Supply, US | A | 1 | each | OTS | | |
| | 40-0081 | USB A/A Cable, Black | A | 1 | each | OTS | | |
| | 40-0084 | USB to Car Power Adapter | A | 1 | each | OTS | | To be included |
| | 50-0083 | Hook & Loop (Velcro), Black, 2" wide | A | 2 | inch | OTS | | To be applied t |

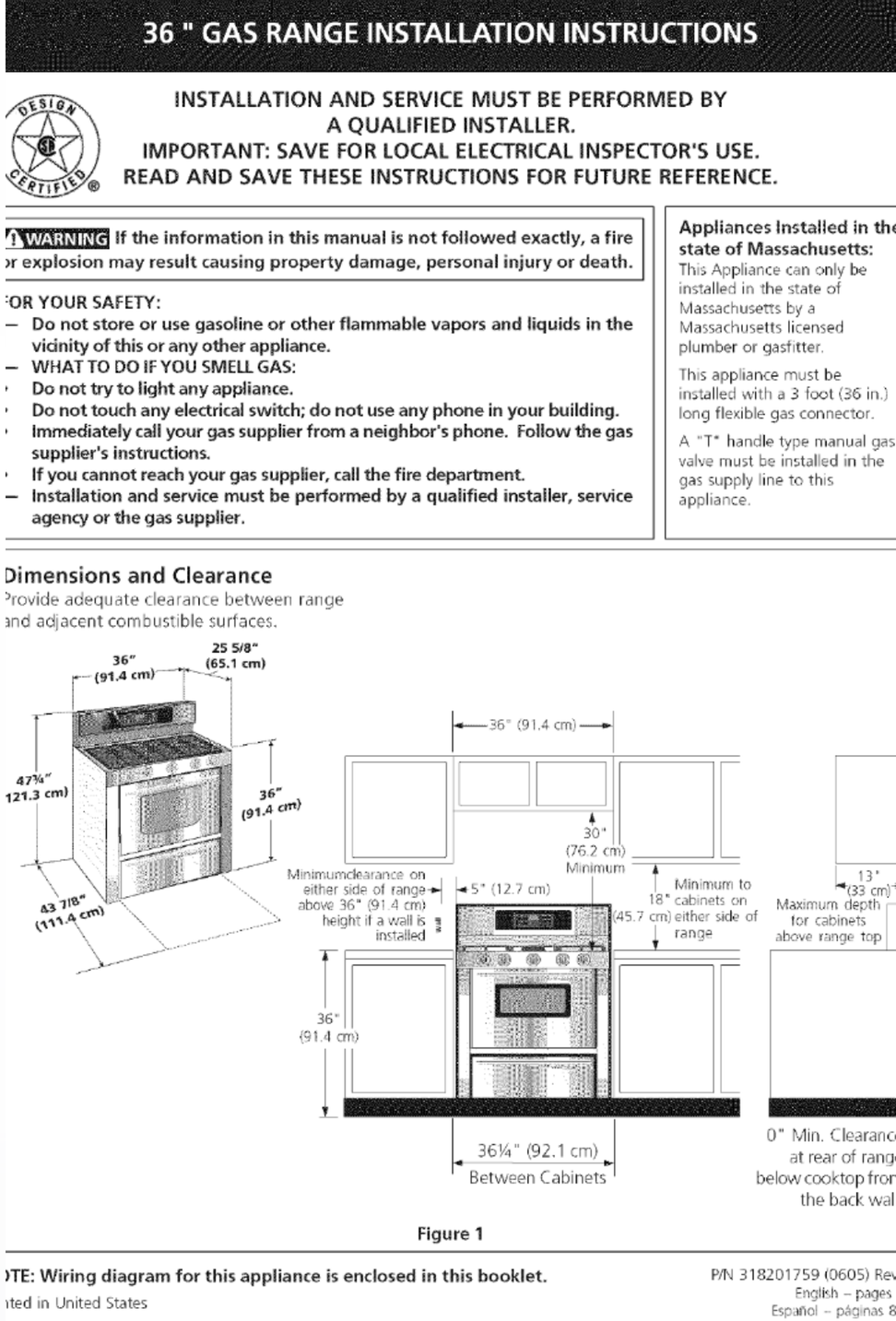
# Troubleshooting Resources

| Information Requirement | Resource Reference |
| --- | --- |
| Work order directs you to check out operation of the relay controlling heating/cooling thermostat | Operator's Manual |
| New door switch required | Operator's Manual |
| Customer lives in a remote area and inquires whether there is some reference he can use if dryer malfunctions on the weekend | Piping Schematic |
| Customer wants to know how to program thermostat | Common Problem Troubleshooting Guide |



# More Troubleshooting Resources

| Information Requirement | Resource Reference |
| --- | --- |
| Customer inquiries if she can convert her pool heater to natural gas and run it from the existing house line | Parts Assembly Chart including Parts Numbers |
| Customer inquiries whether it is okay to polish exterior of water heater | Installation Instructions |
| If the Unit has to be level | Wiring Schematic |



36 " GAS RANGE INSTALLATION INSTRUCTIONS

INSTALLATION AND SERVICE MUST BE PERFORMED BY A QUALIFIED INSTALLER.
IMPORTANT: SAVE FOR LOCAL ELECTRICAL INSPECTOR'S USE.
READ AND SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE.

**WARNING** If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

FOR YOUR SAFETY:
- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- WHAT TO DO IF YOU SMELL GAS:
- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

**Appliances Installed in the state of Massachusetts:**
This Appliance can only be installed in the state of Massachusetts by a Massachusetts licensed plumber or gasfitter.

This appliance must be installed with a 3 foot (36 in.) long flexible gas connector.

A "T" handle type manual gas valve must be installed in the gas supply line to this appliance.

Dimensions and Clearance

Provide adequate clearance between range and adjacent combustible surfaces.

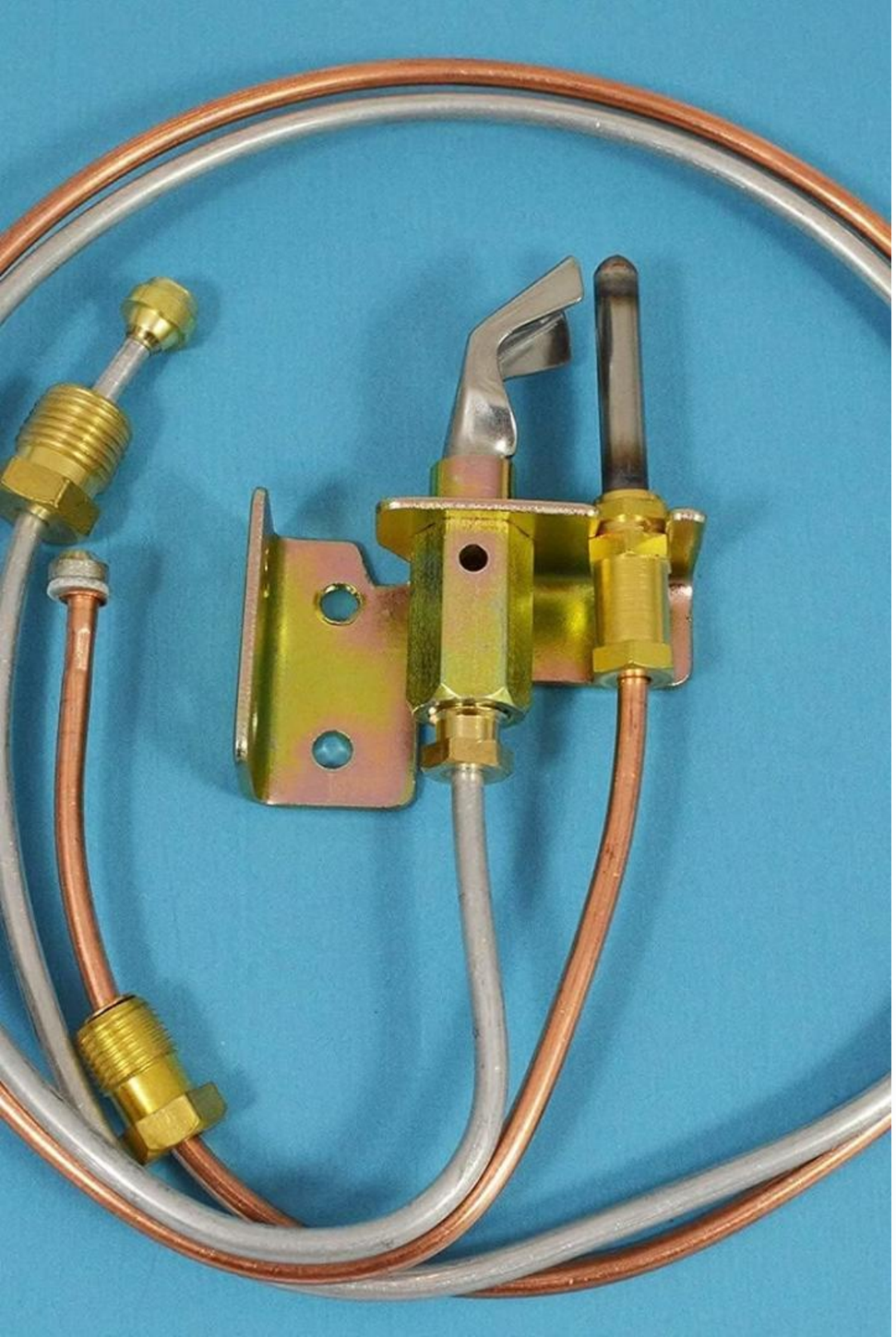


Figure 1

NOTE: Wiring diagram for this appliance is enclosed in this booklet.

Printed in United States

P/N 318201759 (0605) Rev
English – pages
Español – páginas
Wiring Diagram - pages



# Pilot Light Troubleshooting

## Problem: Pilot Does Not Stay Lit

Possible reasons why the pilot does not stay lit when the red button is released:

- Loose thermocouple
- High limit is open
- Thermostat not calling for heat

## Loose Thermocouple Service

When a loose thermocouple is the reason why the pilot does not stay lit, the service requirement is to:

- Replace the thermocouple

# Yellow Flame Troubleshooting

## Problem: Yellow Flame and Sooting

Possible causes for a yellow flame and sooting problem:

- Scale on top of burner
- Gas pressure is too high
- Gas pressure is too low

## Scale on Burner Service

When scale on top of the burner causes a yellow flame and sooting, the service requirement is to:

- Shut off heater and remove scale

# Understanding Pictorial Drawings

## 3D

### Dimensional View

Shows length, width, and height in a single view

## 1

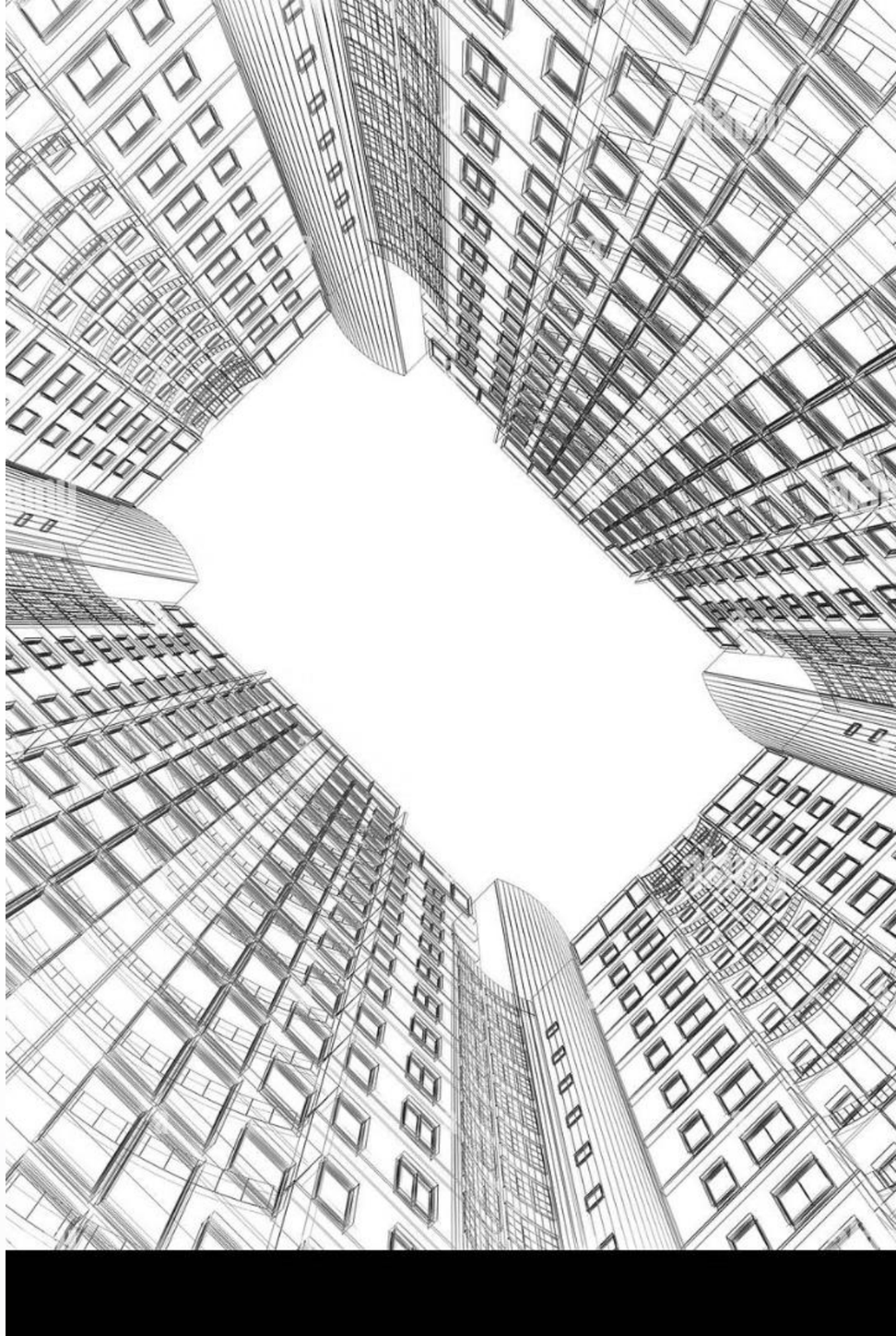
### Single View

Requires only one drawing to convey the object's appearance

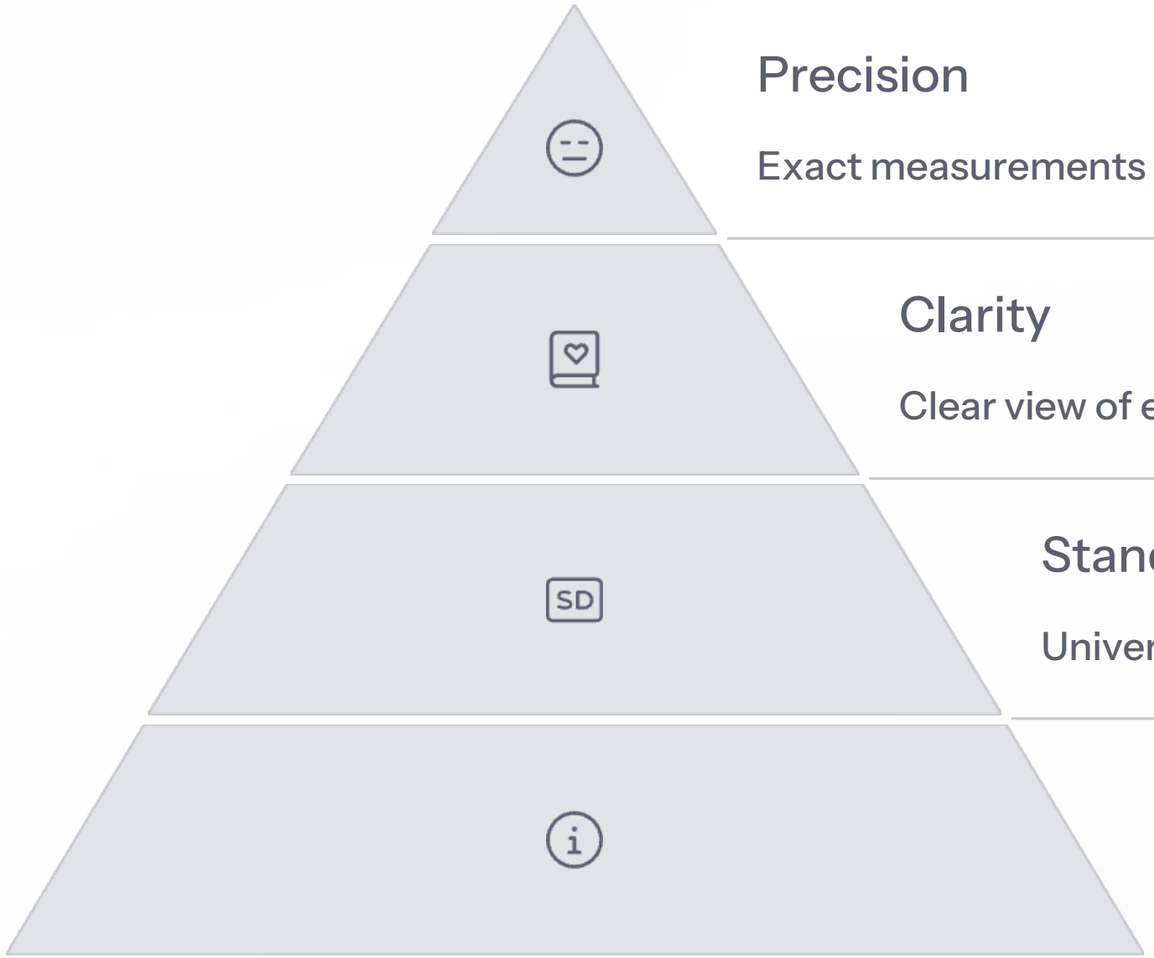
## 100%

### Comprehension Rate

Even inexperienced readers can understand pictorials



# Orthographic Projection Benefits




### Precision

Exact measurements without distortion

### Clarity

Clear view of each plane

### Standardization

Universal drawing method

### Detail

Complete information for fabrication

# Isometric Drawing Applications

## Component Visualization

Shows how individual parts look in three dimensions

## Assembly Instructions

Guides technicians in putting components together

## Training Material

Educates new technicians on equipment components

## Repair Reference

Helps identify parts during maintenance

# Piping Drawing Types

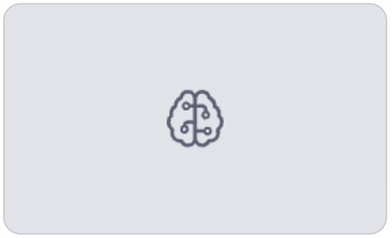
## Orthographic Piping Drawings

- Show pipes in two-dimensional views
- Provide precise measurements and locations
- Often used for detailed installation plans
- May include multiple views to show complete system

## Isometric Piping Drawings

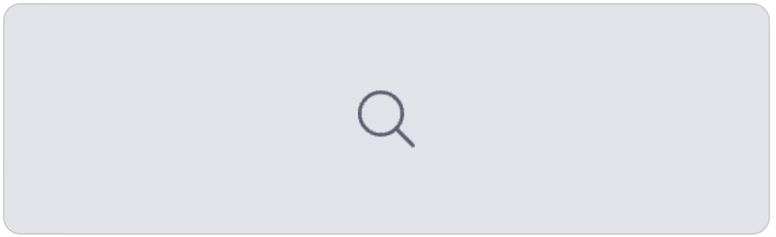
- Show pipes in three-dimensional representation
- Display all important pieces in symbol form
- Easier to visualize the complete system
- Commonly used for installation guidance

# Schematic vs. Wiring Diagrams



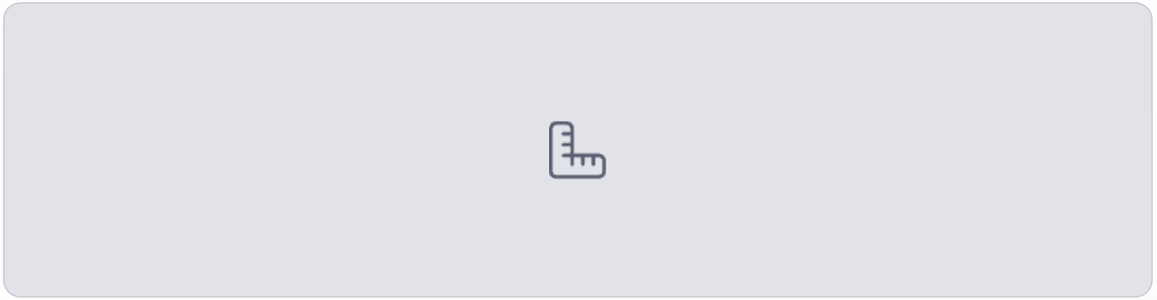
## Schematic Diagrams

Show functional relationships without physical layout



## Wiring Diagrams

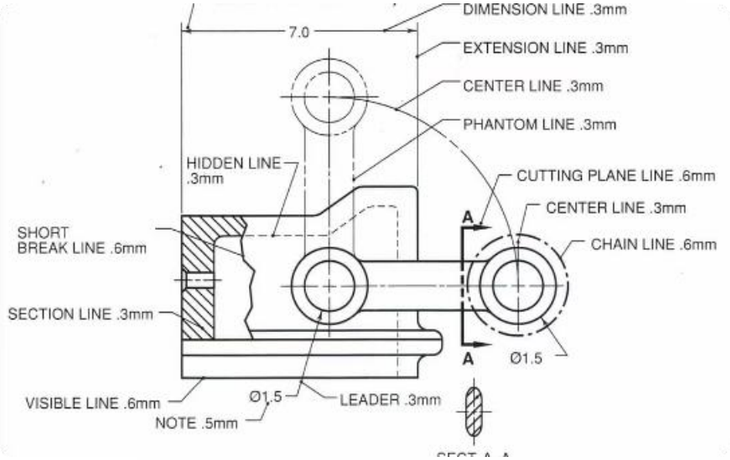
Show physical wire connections and routing



## Combined Diagrams

Some drawings incorporate both schematic and wiring elements

# Line Types and Their Uses

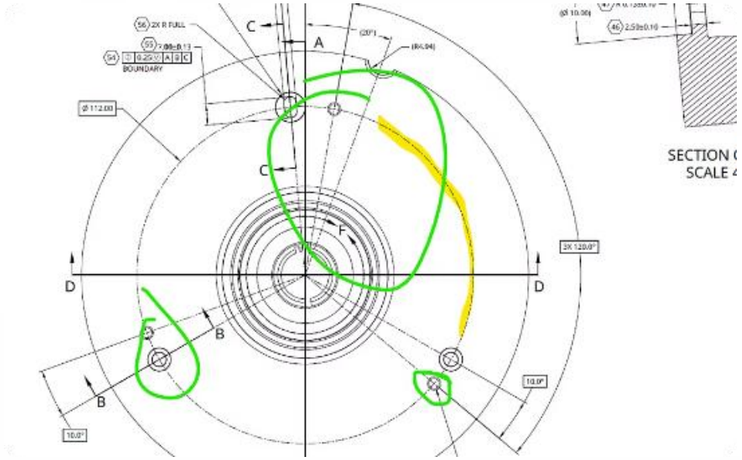



## Object Lines

Thick lines that trace the visible outline of an object, providing clear definition of its visible edges and surfaces.

## Hidden Lines

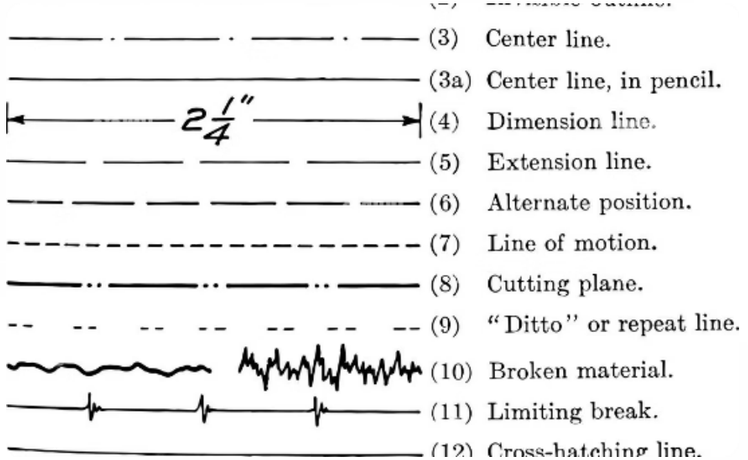
Thin, equally spaced, broken lines that show surfaces and features of the object that are hidden in the chosen views, allowing visualization of concealed elements.




## Centerlines

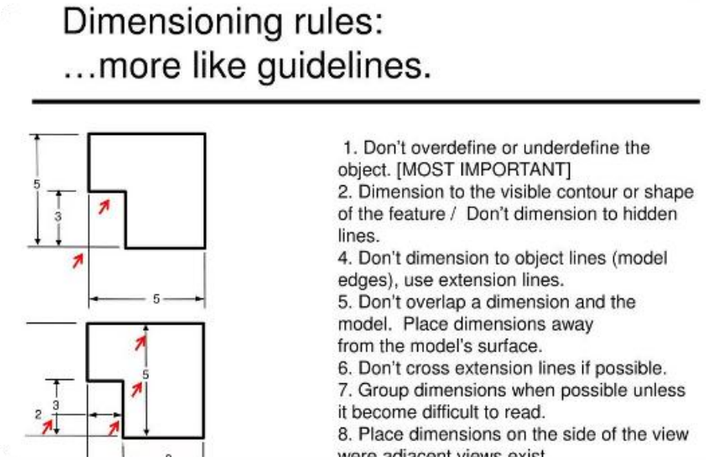
Thin, broken lines with long and short lines spaced alternately that indicate the exact center of an object, essential for symmetrical components and hole placements.

# More Line Types and Their Uses



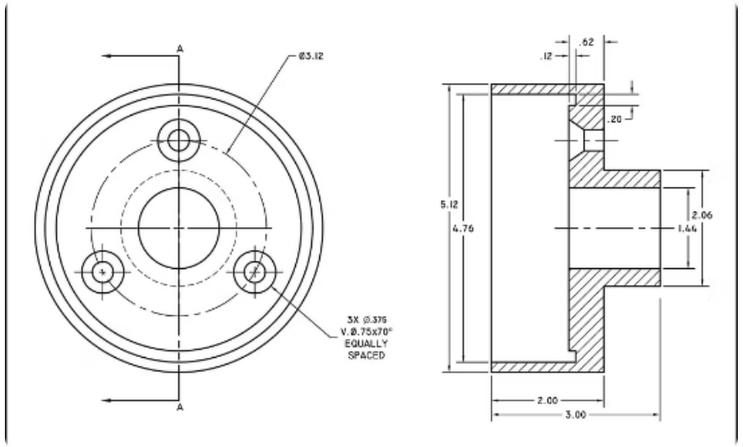

## Extension Lines

Thin lines that do not touch the object lines and extend them out to a convenient space for dimensioning, creating clear measurement references.




## Dimension Lines

Thin lines that terminate with arrowheads and touch the extension lines, giving the object's measured dimensions such as height, width, and length.




## Section Lines

Thin lines used to indicate where a cutting plane has passed through an object, showing the internal features that would be visible in that cross-section.

# Piping Symbol Standards

## International Organization for Standardization (ISO)

Publishes international standards for piping symbols used globally.

## CSA Group

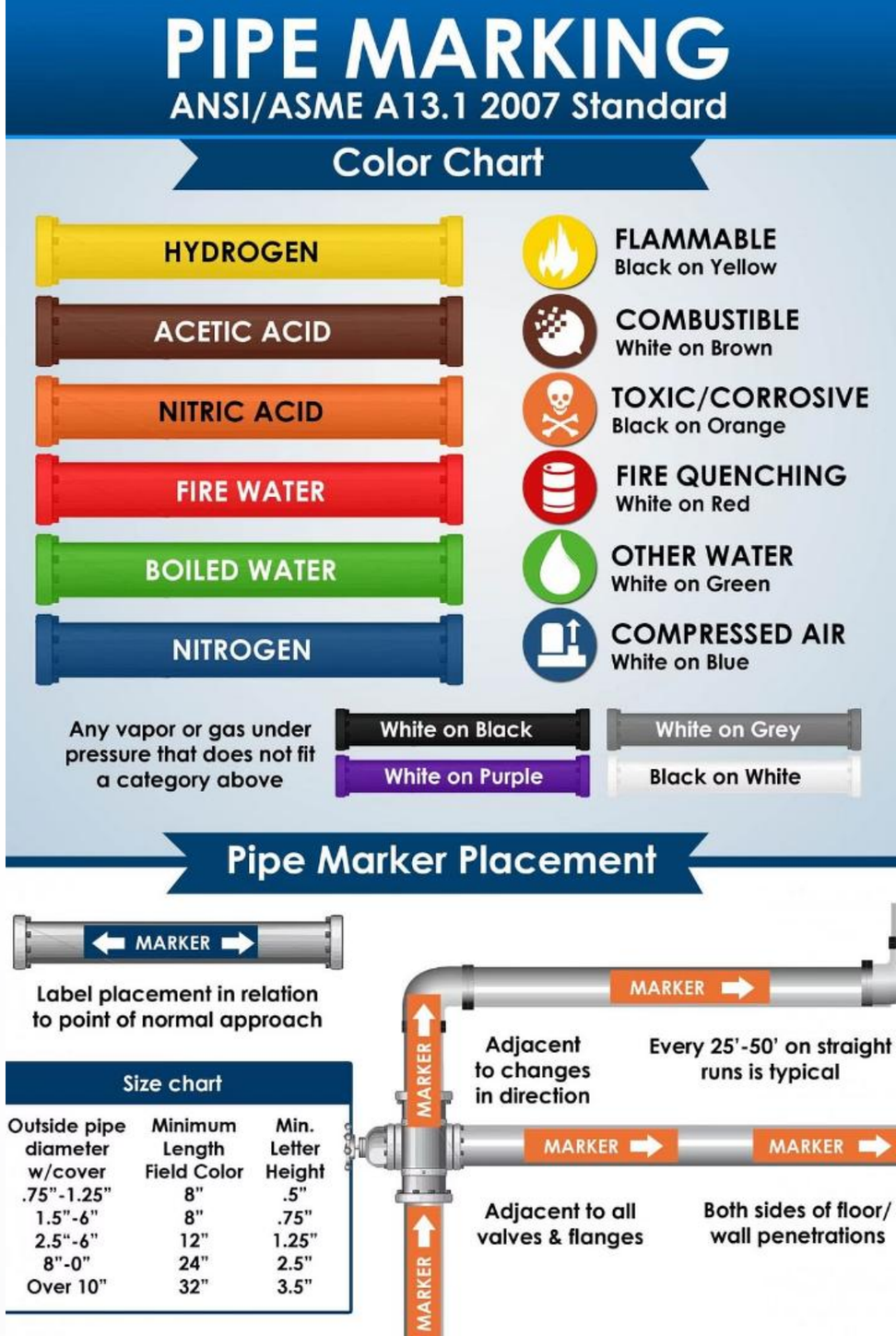
Develops Canadian standards for piping symbols and notations.

## American National Standards Institute (ANSI)

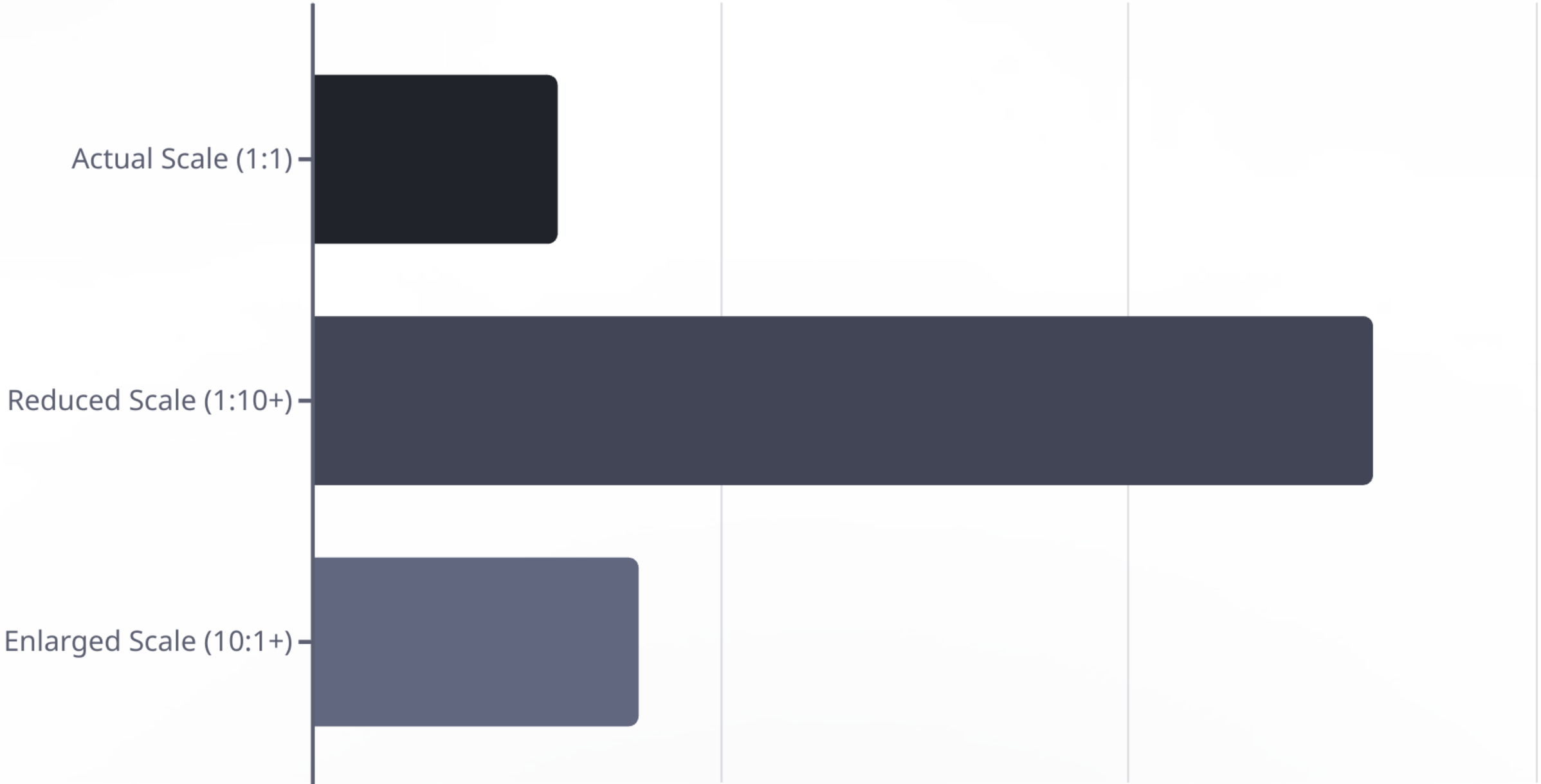
Establishes American standards for piping symbols and drawings.

## Symbol Tables

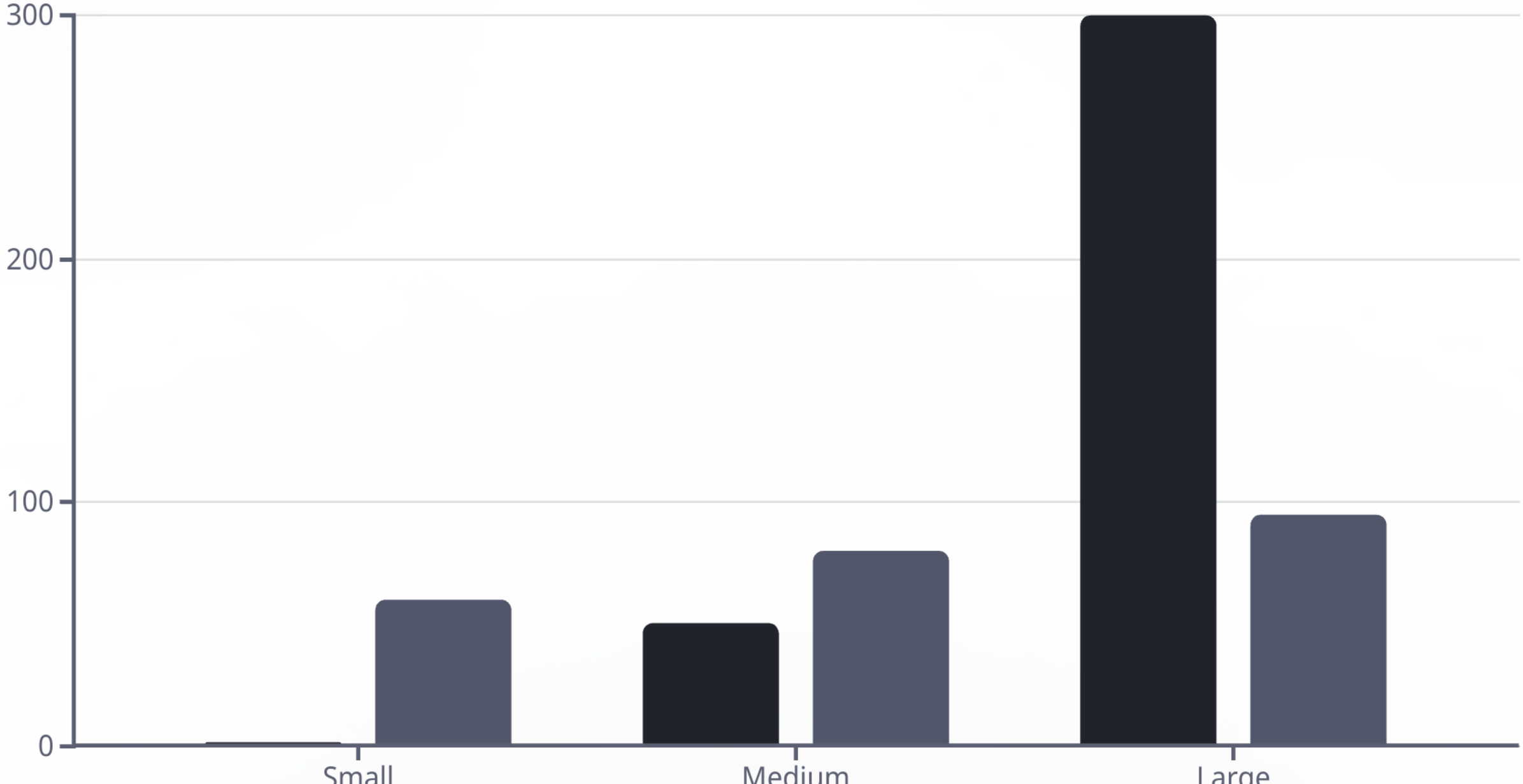
These organizations publish reference tables for welding, piping, surface texture, and electrical elements.



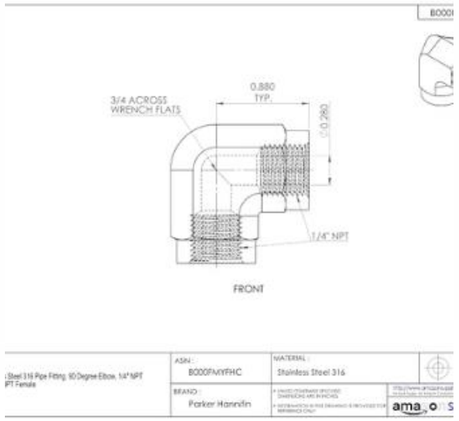
# Scale Types and Applications

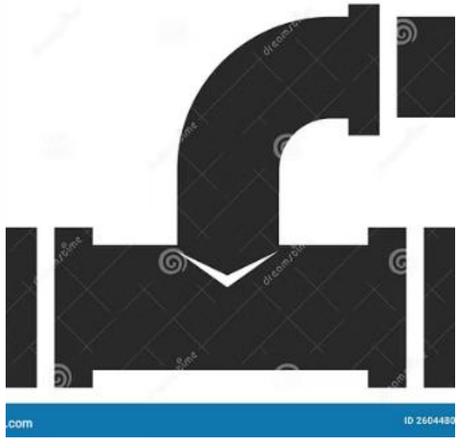


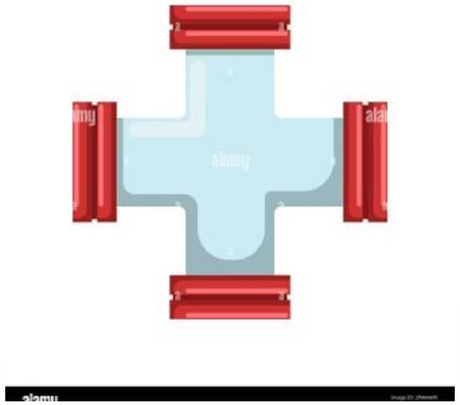
# Specification Importance by Project Size

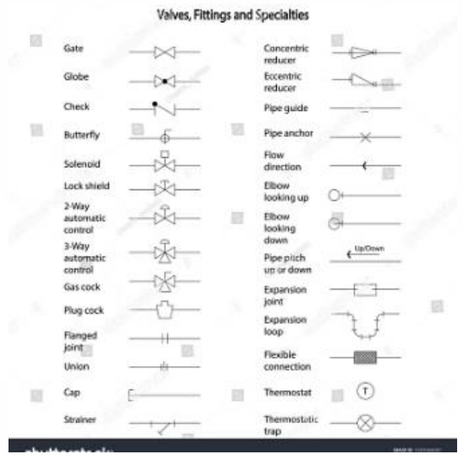


# Common Piping Symbols








Piping symbols provide a standardized way to represent various fittings and components in piping systems. These symbols are used consistently across drawings to ensure clear communication between designers, engineers, and installers. Understanding these symbols is essential for gas technicians to correctly interpret piping drawings.

# Materials List Components

100%

Part Coverage

Complete inventory of all components needed

#123

Part Numbers

Unique identifiers for each component

3D

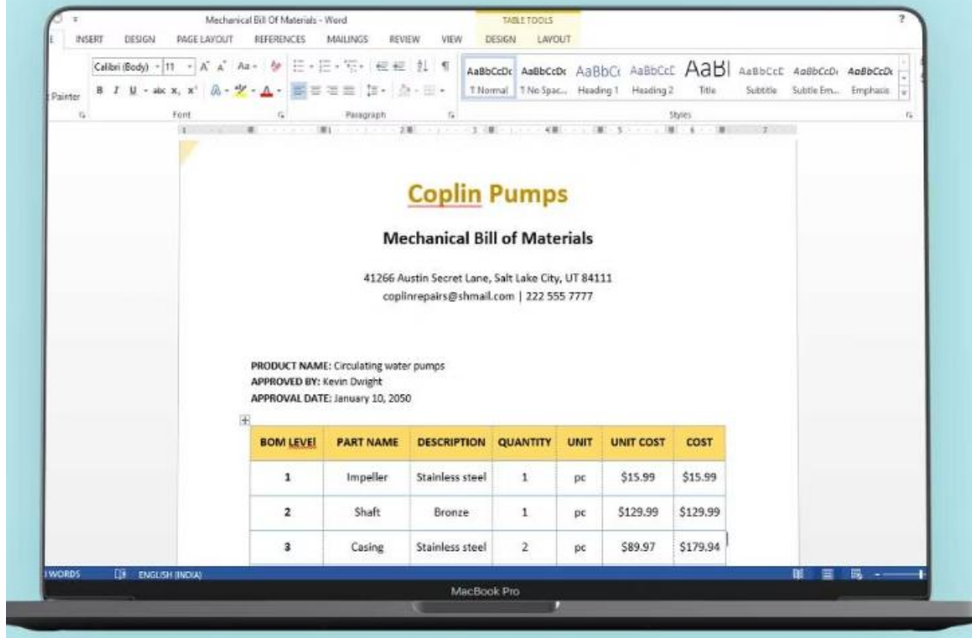
Dimensions

Size specifications for all parts

The materials list or bill of materials provides a comprehensive inventory of all parts required for a project, including their identification numbers, quantities, and dimensions. This essential reference ensures that all necessary components are available during installation or assembly.

MS WORD

Quickly Open Microsoft Word and Edit as Required



# Drawing Interpretation Process

## Identify Drawing Type

Determine if it's a pictorial, orthographic, isometric, or schematic drawing

## Check Scale

Note the scale to understand the relationship between drawing and actual size

## Recognize Symbols

Identify standard symbols and lines used in the drawing

## Review Dimensions

Examine measurements and specifications

## Read Supplementary Information

Check title block, revision block, and materials list

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# Practical Application of Drawing Knowledge

## Review Project Requirements

Understand what needs to be installed or repaired based on work orders and customer needs.

## Consult Appropriate Drawings

Select the right drawings and specifications for the task at hand, whether it's a mechanical drawing, piping diagram, or wiring schematic.

## Interpret Symbols and Information

Apply knowledge of lines, symbols, and drawing conventions to understand the requirements.

## Execute Installation or Repair

Use the drawing information to correctly complete the work according to specifications.

# Summary: Mechanical Drawings and Specifications

## Essential Tools

Mechanical drawings are necessary tools in the gas industry, serving as "maps" for installation and connection.

## Various Drawing Types

Pictorial, orthographic, isometric, detail, assembly, piping, and schematic drawings each serve specific purposes.

## Visual Language

Lines and symbols form a standardized language that communicates precise information about components and systems.

## Supporting Documentation

Specifications, revision blocks, and materials lists provide essential supplementary information.

## Critical Skills

The ability to interpret mechanical drawings is fundamental for gas technicians to perform their work correctly and safely.

# CSA Unit 6

# Chapter 4
# Graphs and Charts

Graphs and charts are what you use to represent facts, statistics, or the relationship between physical properties. A visual or graphical description is often easier to understand than a numerical or verbal description. The gas technician/fitter must know how to read and correctly interpret the many types of graphs and charts in the gas industry.

## Objectives

At the end of this Chapter, you will be able to:

- identify types of graphs and charts; and
- locate data on graphs.


# Terminology

## Chart

Visual or graphical representation of data

## Graph

Same as chart

# Types of Graphs and Charts

A graph or chart is a line or diagram showing how one quantity depends on, changes, or relates with, another. Graphs and charts represent facts, statistics, or the relationship between physical properties. A visual or graphical description is often easier to understand than a numerical or verbal description.

# Applications of Graphs and Charts

### Graphical Presentation of Information

Using visual elements to communicate data clearly and effectively

### Graphical Analysis

Examining data visually to identify patterns, trends, and relationships

### Computing or Determining Values

Using graphs to calculate or estimate specific data points

# Factors Affecting Graph Selection

### Audience

Who will be viewing the graph

### Best Representation

Which type best shows the information

### General Purpose

What the graph needs to accomplish

### Significant Features

Key relationships to highlight

### Type/Amount of Information

How much data needs to be displayed

# Common Types of Graphs and Charts

## Bar Graph

Also called bar or column chart

## Pie Chart

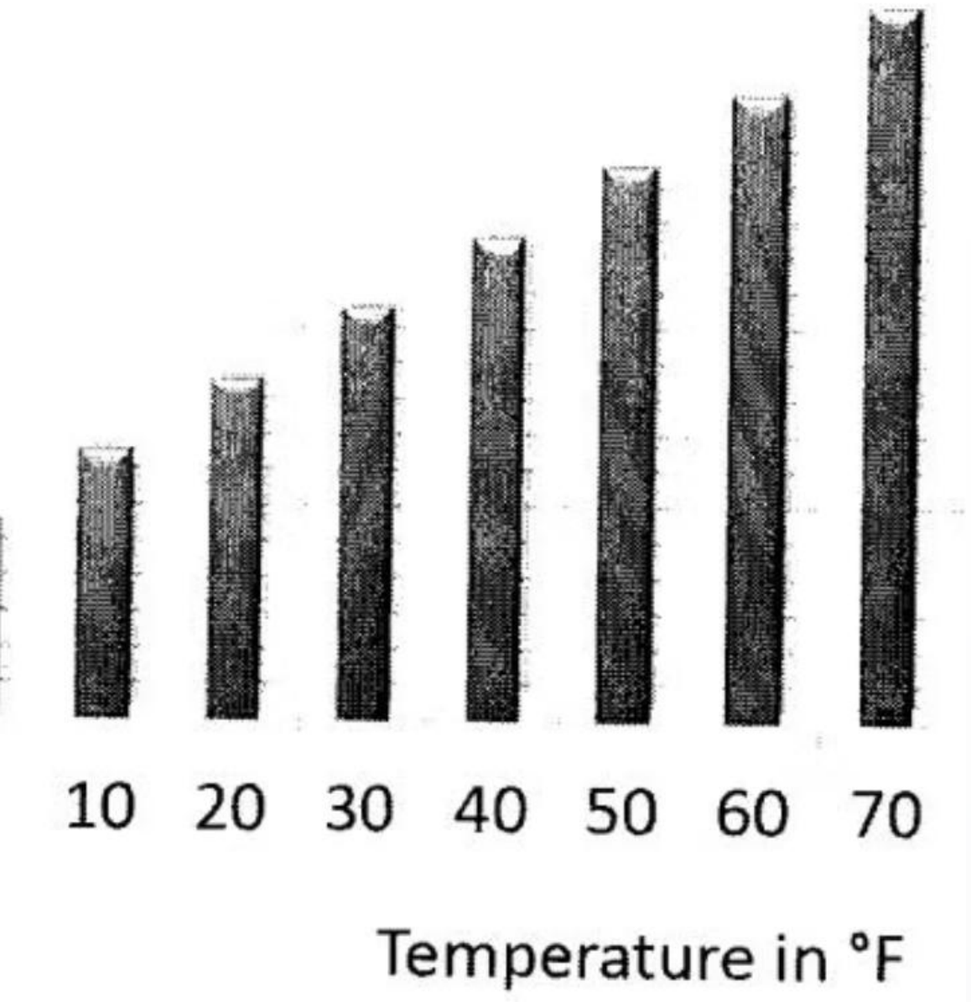
Also called sector chart

## X-Y Graph

Rectangular coordinate line graph

## Flow Chart

Schematic representation of a process




# Bar Graphs

Bar graphs are visual representations of numerical values by bars or columns of different lengths. The bars, which may be vertical or horizontal, begin at a baseline and indicate the relationship between two or more related variables. In Figure 4-1, the two variables are temperature in "F and resistance in ohms for a resistance temperature detector (RTD).

## Present Information to Non-Technical Audience

Easy to understand for all viewers

## Represent Small Numbers of Plotted Values

Works well with limited data points

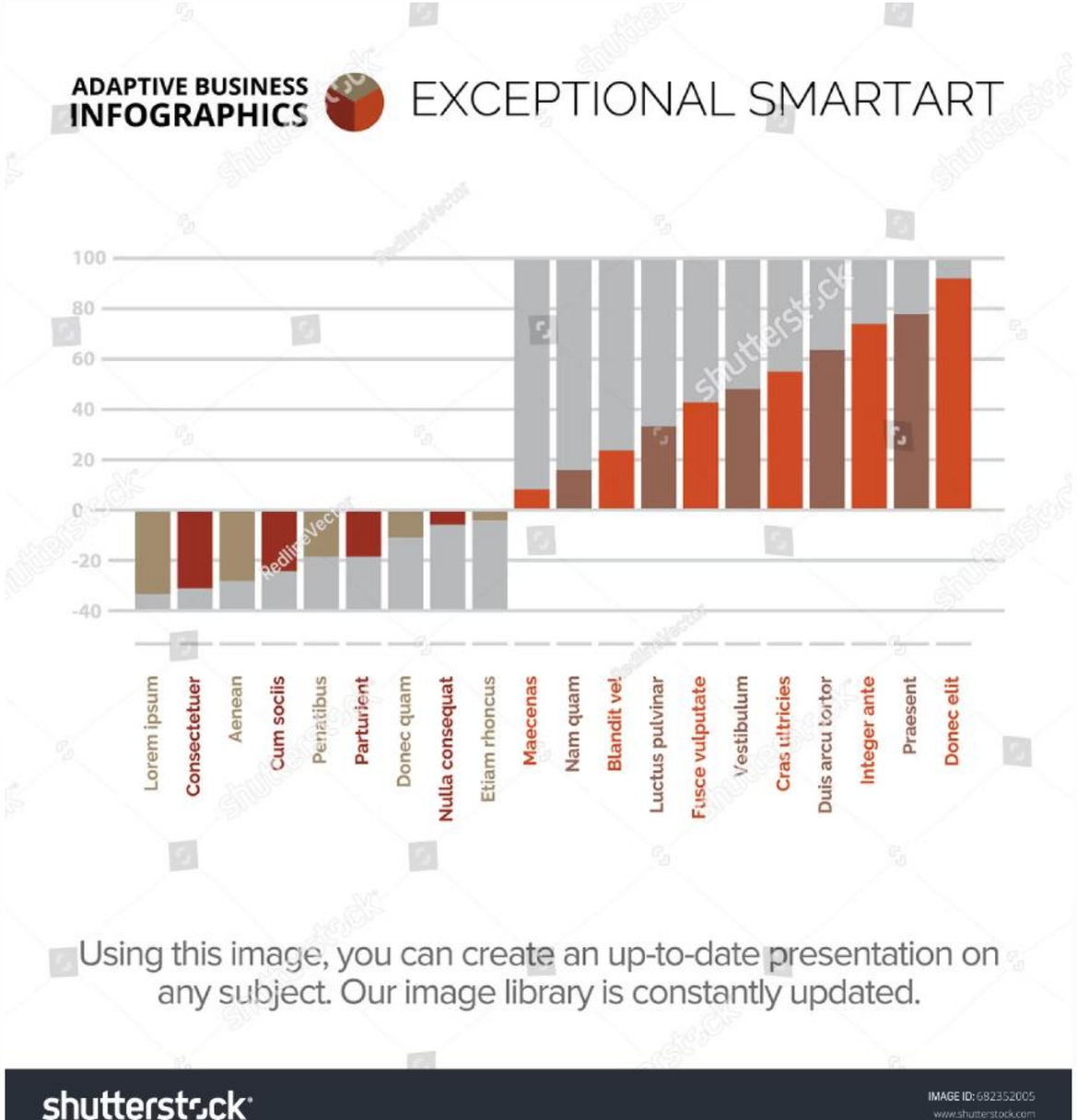
## Simple Comparison of Two Values

Clear visual comparison along two axes

## Represent Data for a Total Period

Shows data relative to point data

# Disadvantages of Bar Charts




## Not Suitable For:

- Comparing several series of data
- Plotting large numbers of values

When dealing with multiple data series or large datasets, other chart types may provide better visualization and clarity.

# Pie Charts

You use pie charts to compare individual parts in relation to their total by representing them as sectors of a circular area. Its common uses are the following:

### Visually Present Data on a Percentage Basis

Shows proportional relationships clearly

### Present a General Overall View

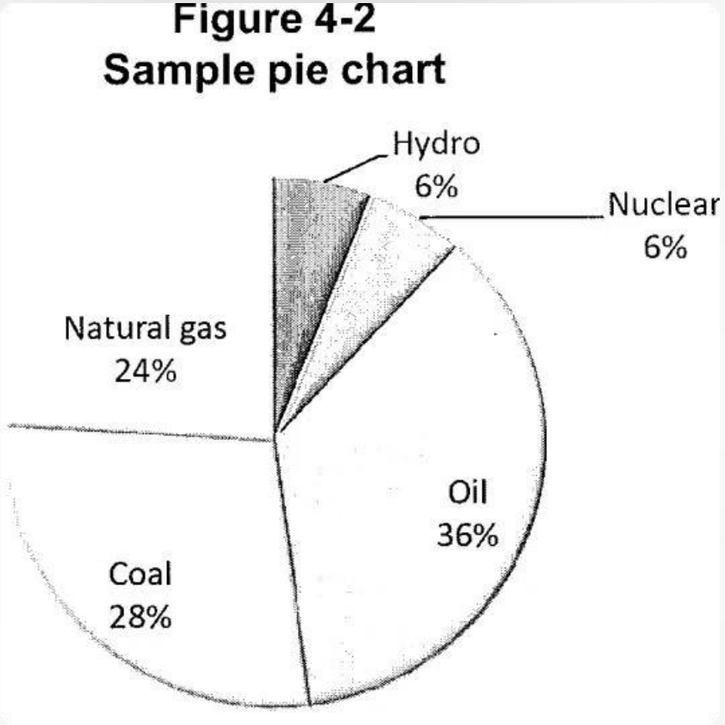
Provides quick understanding of information

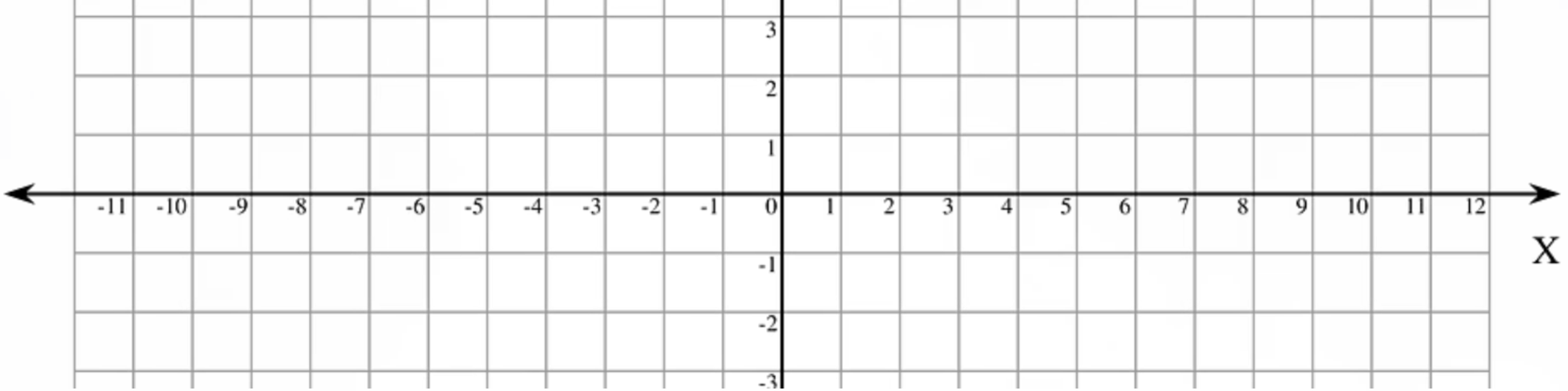
### Show Relationship Between Small Number of Values

Works best with limited data points

### Emphasize Amount of Data Rather Than Trend

Focuses on proportions rather than changes over time






# X-Y Graphs

X-Y graphs have the values of two related variables plotted as points on a coordinates grid. The points are then joined together successively to form a continuous line or curve.

### Compare Large Numbers of Values

Can display many data points in a compact space

### Compare Trends of Several Curves

Multiple data series can be shown on one graph

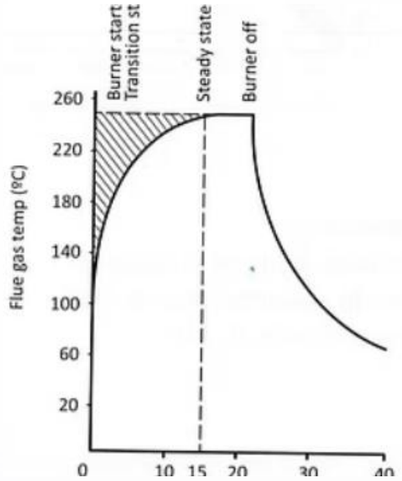
### Calculate Intermediate Values

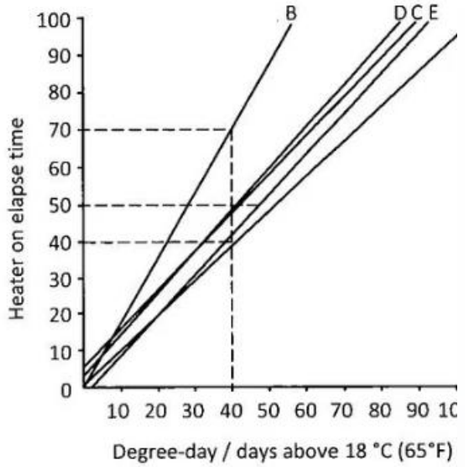
Values that fall between plotted points can be determined

# Reading X-Y Graphs

On X-Y graphs, you see the values of the two variables plotted with reference to two axes that are perpendicular to one another, meeting at a common origin or zero point.

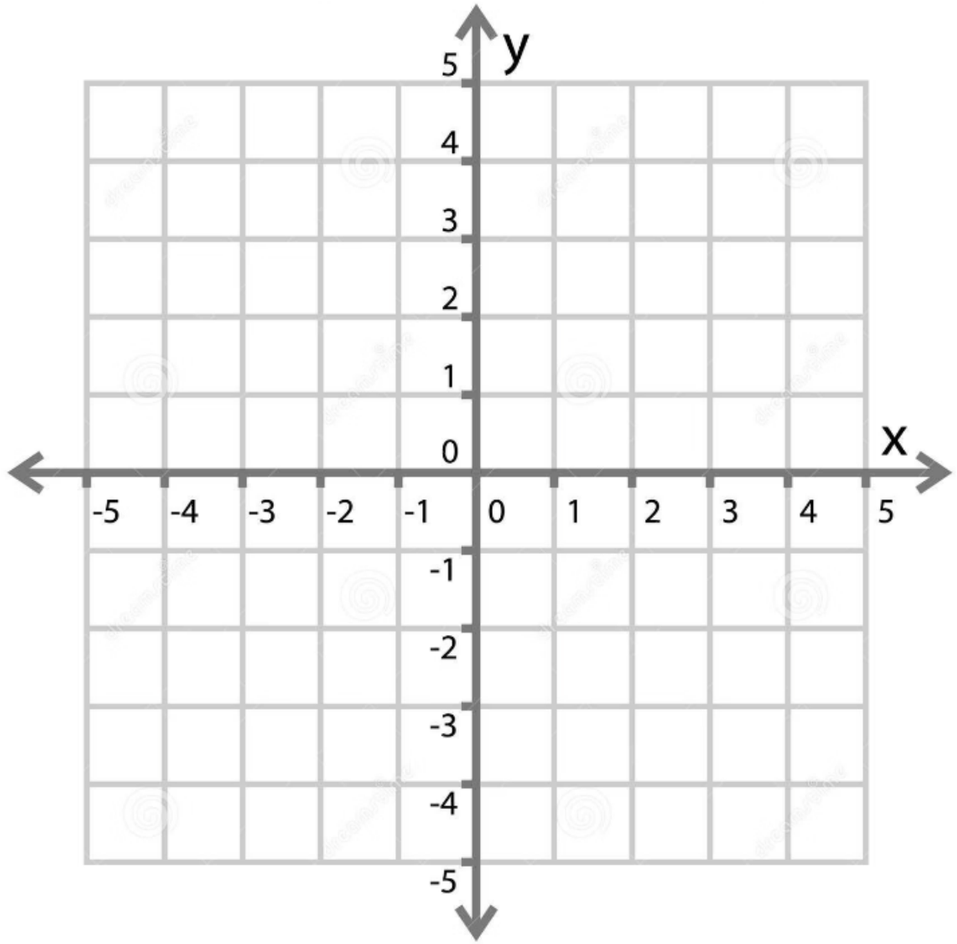
The curve on the X-Y graph in Figure 4-3 represents the relationship between flue gas temperature and the operating time of a burner. The x-axis is the time of burner operation in minutes and the y-axis is the flue gas temperature in degrees Celsius.




The five lines labelled A, B, C, D, and E on the X-Y graph in Figure 4-4 represent the relationship between outside air temperature (x-axis) and the operating time (y-axis) of each of five different building's heating systems.

# Disadvantages of X-Y Graphs




dreamstime.com ID 299624485 © Dzmitryshashko

## Generally Unsuitable For:

- Representing small numbers of plotted values in a series
- Showing changes or differences in absolute amounts
- Showing extreme or irregular movements of data

In these cases, other chart types may provide better clarity and visual representation of the data.

# Flow Charts

A flow chart is generally a schematic representation of a process flow, showing the information in several ways, including:

- schematic symbols;
- labelled blocks; and
- combinations of all three.

The flow chart in Figure 4-5 shows the water circulation flow-path through a hot-water heating system. In Figure 4-5, the arrowheads indicate the direction of water flow through the system, schematic symbols represent the valves, and the boiler and radiator are in pictorial form.

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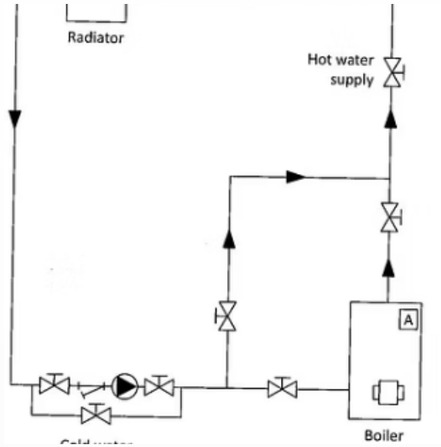


# Locating Data on Graphs

The X-Y chart in Figure 4-6 is what you use to determine the correct termination height for a vent on roofs with a pitch greater than 9/12. You can see the roof pitch values along the x-axis, and the minimum allowable vertical distance from the roof surface to the lowest opening in the top along the y-axis.

## Identify the Variables

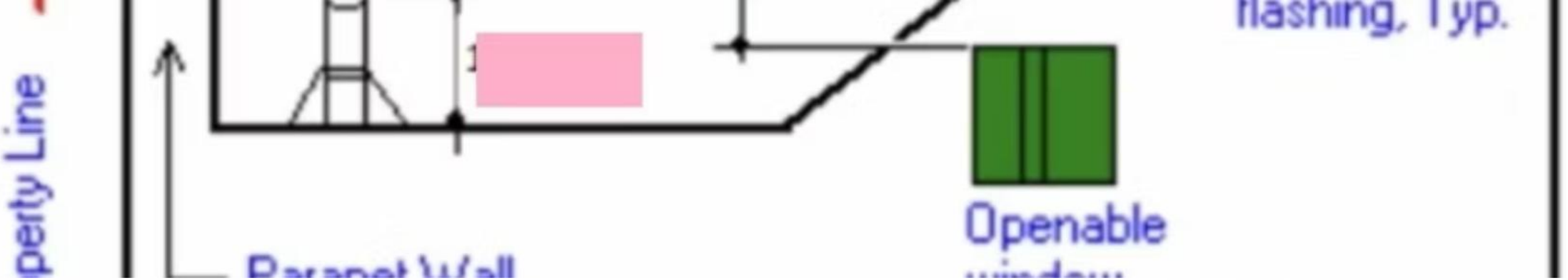
Understand what each axis represents and the units of measurement

## Locate the Point of Interest

Find where your specific values intersect on the graph

## Read the Corresponding Value

Trace to the appropriate axis to determine the result




# Using Charts to Determine Vent Termination Height

### Determine the Pitch of the Roof

Find this value on the x-axis

### Locate the Point on the Diagonal Line

Trace a line from the roof pitch value vertically up the y-axis

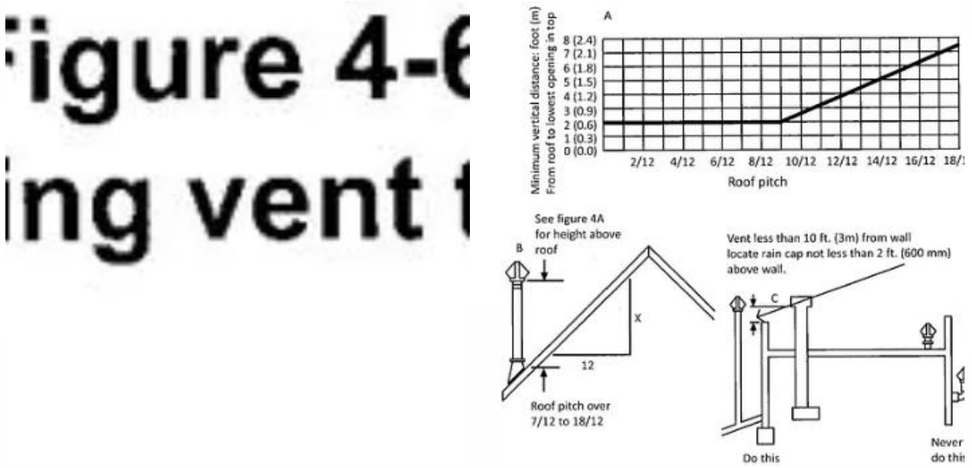
### Trace the Horizontal Line

Follow the horizontal line nearest the point where the roof pitch value crosses the diagonal line back to the distance scale along the y-axis

### Read the Corresponding Value

This indicates the minimum allowable vertical distance between the vent or chimney discharge and the nearest obstruction or opening

# Practical Application of Vent Termination Charts




## Reading the Chart

The chart provides a visual guide for determining the correct height for vent termination based on roof pitch. By following the steps outlined in the previous section, gas technicians can ensure proper installation that meets safety standards.

## Importance of Accuracy

Precise measurement and correct interpretation of these charts is essential for proper venting, which affects both the efficiency of gas appliances and the safety of the installation. Always verify measurements and consult local codes for specific requirements.


# CSA Unit 6

# Chapter 5
# Units of Measurement and Conversion Factors

A gas technician/fitter needs to know both the traditional Units of measurement and the SI (metric) Units of measurement in technical manuals, specifications, drawings, and graphs. Installing and servicing the gas equipment in accordance with specifications requires prior understanding of the Units of measurement.

# Purpose of Understanding Measurement Units

## Technical Documentation

Gas technicians must interpret technical manuals and specifications that use various measurement units.

## Equipment Installation

Proper installation of gas equipment requires understanding specifications in both imperial and metric units.

## Service and Maintenance

Servicing gas equipment according to specifications requires knowledge of measurement units.

## KIDS CONVERSION CHART

| LENGTH CONVERSION | WEIGHT CONVERSION |
|---|---|
| 1 centimeter (cm) = 10 millimeters (mm) | 1 milligram (mg) = 1,000 micrograms (mcg) |
| 1 decimeter (dm) = 10 centimeters (cm) | 1 gram (g) = 1,000 milligrams (mg) |
| 1 meter (m) = 100 centimeters (cm) | 1 ounce (oz) = 28.35 grams (g) |
| 1 meter (m) = 10 decimeters (dm) | 1 pound (lb) = 453.6 grams (g) |
| 1 kilometer (km) = 1,000 meters (m) | 1 kilogram (kg) = 1,000 grams (g) |

| LIQUID (CAPACITY) CONVERSION | TEMPERATURE (Fahrenheit-Celsius) |
|---|---|
| 1 tablespoon (tbsp) = 3 teaspoon (tsp) | 350°F = 180°C |
| 1 fluid ounce (fl. oz) = 2 tablespoons (tbsp) | 375°F = 190°C |
| 1 cup (c) = 8 fluid ounces (fl. oz) | 400°F = 200°C |
| 1 pint (pt) = 2 cups (c) | 425°F = 220°C |

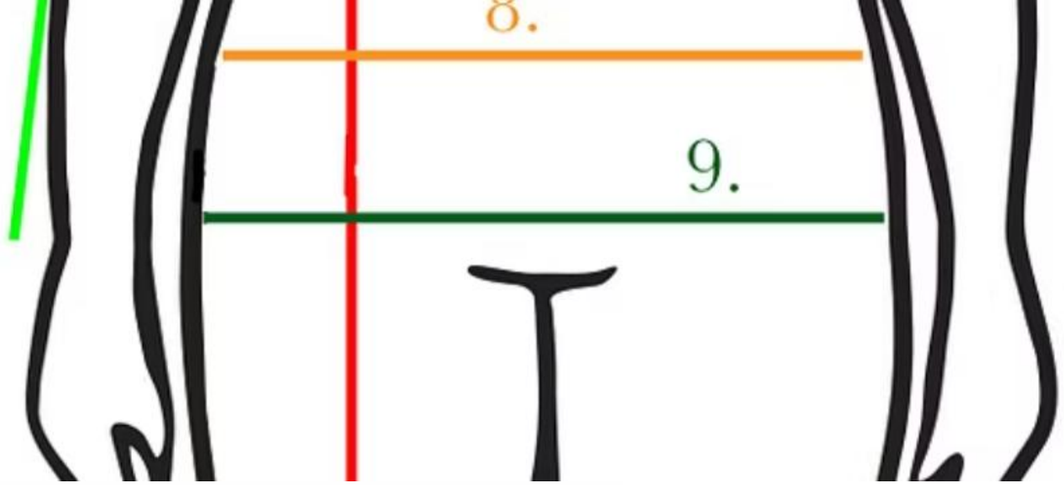
# Learning Objectives

1 ### Identify Units of Measurement

Identify Units of measurement for various components the gas technician/fitter will encounter

2 ### Convert Between Units

Convert from one Unit of measurement to another




5.
Full bust
6.
Under bust
7.

# Terminology Overview

| Term | Abbreviation (symbol) | Definition |
| --- | --- | --- |
| Imperial Units | | System of measurement derived from earlier English system of measurement Units |
| International System of Units | SI | A rationalized, coherent, simplified system of measurement based on the metric system |

# International System of Units (SI)

## Development of SI Units

Countries that participate in the activities of the General Conference of Weights and Measures (CGPM), the International Organization for Standardization (ISO), and the International Electrotechnical Commission (IEC) have developed and approved the International System of Units (SI), a rationalized, coherent, simplified metric-based system of measurement.

## Canadian Participation

Canada is a member of all these organizations.

However, many Units of measurement that the gas industry uses are still in imperial Units of measurement.

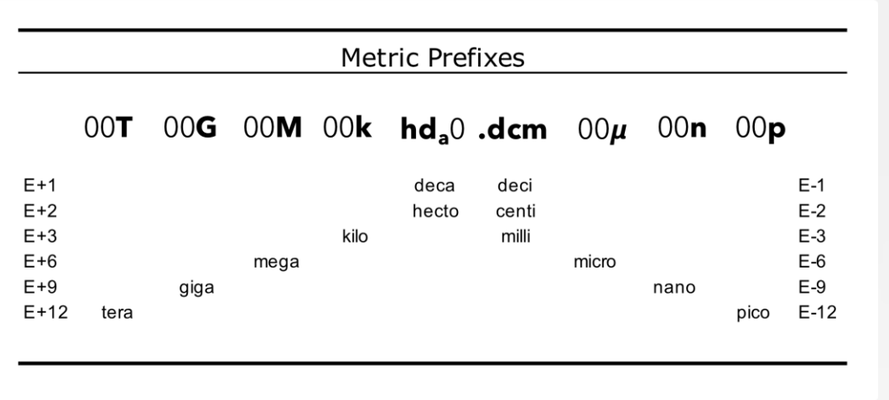
# Understanding Measurement Prefixes

The use of prefixes indicates the order of magnitude of the quantity noted. Thus, the prefix 'k' used with the symbol 'W' for watts, indicates 1000 watts or a kilowatt. The prefix 'M' used with the symbol J for joule indicates 1,000,000 joules or a megajoule (MJ).

Table 5-1 lists the prefixes that a gas technician/fitter typically encounters.

# Common Measurement Prefixes

| Symbol | Name | Multiplying factor |
|---|---|---|
| G | giga | 1 000 000 000 = 109 |
| M | mega | 1 000 000 = 106 |
| k | kilo | 1,000 = 103 |
| d | deci | 0.1 = 10-1 |
| c | centi | 0.01 = 10-2 |
| m | milli | 0.001 = 10-3 |
| µ | micro | 0.000 001 = 10-6 |
| n | nano | 0.000 000 001 = 10-9 |
| p | pico | 0.000 000 000 001 = 10-12 |



| mperial | | Metri |
|---|---|---|
| rleycorn | → | 0.7c |
| ch (3 barleycorns) | → | 2.5c |
| nd (4 inches) | → | 10cr |
| ot (4 hands) | → | 30cr |
| rd (3 feet) | → | 90cr |
| ain (22 yards) | → | 20m |
| rlong (10 chains) | → | 201r |
| e (8 furlongs) | → | 1.6k |
| ague (3 miles) | → | 4.8k |

# Special Note on "M" in Imperial Measurements

> Sometimes in imperial measurement, "M" represents a multiplying factor of 1,000 = 103 (e.g., MBtu/h = 1,000s of Btu/h).

This is an important distinction to remember when working with both imperial and SI units, as the same prefix can have different meanings depending on the measurement system being used.

# Measurement Units in Gas Technology

Table 5-2 provides both the imperial and SI Units that the industry uses to measure various gas technology items.

## Length Measurements

Used for pipe dimensions, clearances, and installation specifications

## Area Measurements

Used for ventilation requirements and surface areas

## Volume Measurements

Used for gas consumption and storage capacity

## Pressure Measurements

Critical for safe gas system operation

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# Length Measurement Units

## Imperial Units

- Inches (in)
- Feet (ft)
- Miles (mi)

## SI (Metric) Units

- Centimetres (cm)
- Metres (m)
- Kilometres (km)

# Area Measurement Units

## Imperial Units

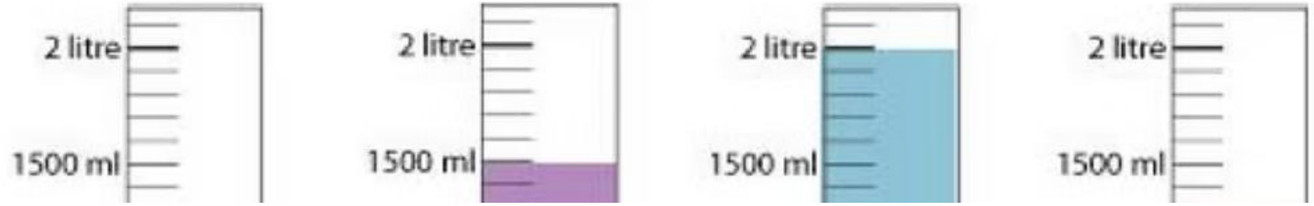
- Square inches ($in^2$)
- Square feet ($ft^2$)

## SI (Metric) Units

- Square centimetres ($cm^2$)
- Square metres ($m^2$)

can be measured.

The number at the top of the last ring tells the capacity for the graduated cylinder. Capacity is the amount of liquid that a container can hold.




The symbol **mL** stands for milliliter and **L** stands for liter.

YELLOW = 500 mL

# Volume Measurement Units

## Volume of Liquid

- Imperial: Gallon (gal)
- SI: Litre (l)

## Volume of Gas

- Imperial: Cubic feet ($ft^3$)
- SI: Cubic metres ($m^3$)

# Flow Rate and Calorific Value Units

## Flow Rate of Gas

- Imperial: Cubic feet per hour ($ft^3/h$)
- SI: Cubic metres per hour ($m^3/h$)

## Calorific Value of a Fuel Gas

- Imperial: British thermal Units per cubic foot ($Btu/ft^3$)
- SI: Megajoules per cubic metre ($MJ/m^3$)

# Pressure Measurement Units

## Pounds per square inch (psig)

Common imperial unit for measuring gas pressure

## Inches water column (inches w.c.)

Used for lower pressure measurements in gas systems

## Kilopascal (kPa)

SI unit used for all pressure measurements

# Mass Measurement Units

## Imperial Units

- Ounces (oz)
- Pounds (lb)

## SI (Metric) Units

- Grams (g)
- Kilograms (kg)

# Temperature Measurement Units

## Imperial Unit

Degrees Fahrenheit (°F)

Water freezes at 32°F and boils at 212°F at standard pressure

## SI (Metric) Unit

Degrees Celsius (°C)

Water freezes at 0°C and boils at 100°C at standard pressure


# Heat and Power Measurement Units

## Heat (Energy)

Imperial: British thermal Units (Btu)

SI: Joules (J)

## Heat Rate (Power)

Imperial: Horsepower (HP), British thermal Units per hour (Btu/h) (sometimes written Btuh)

SI: Watts (W), Kilowatts (kW)

OF UNITS FOR AREA

| Measurement | Conversion |
|---|---|
| e Meter ($m^2$) | 1 |
| ntimeter ($cm^2$) | 0.000 |
| lometer ($km^2$) | 1,000,0 |
| llimeter ($mm^2$) | 0.0000 |
| e Foot ($ft^2$) | 0.092 |
| e Inch ($in^2$) | 0.0006 |
| tare (ha) | 10,00 |
| re (ac) | 4046.8 |

# Introduction to Conversion Factors

Conversion factors are what you use to calculate the value of a measurement as a different Unit of measurement. For example, you use a conversion factor of 25.4 to convert an inch measurement to a millimetre measurement (e.g., 2 inches = 2 x 25.4 or 50.8 mm).

Table 5-3 lists a number of conversion factors that a gas technician/fitter typically uses.

# Length Conversion Factors

## 25.4

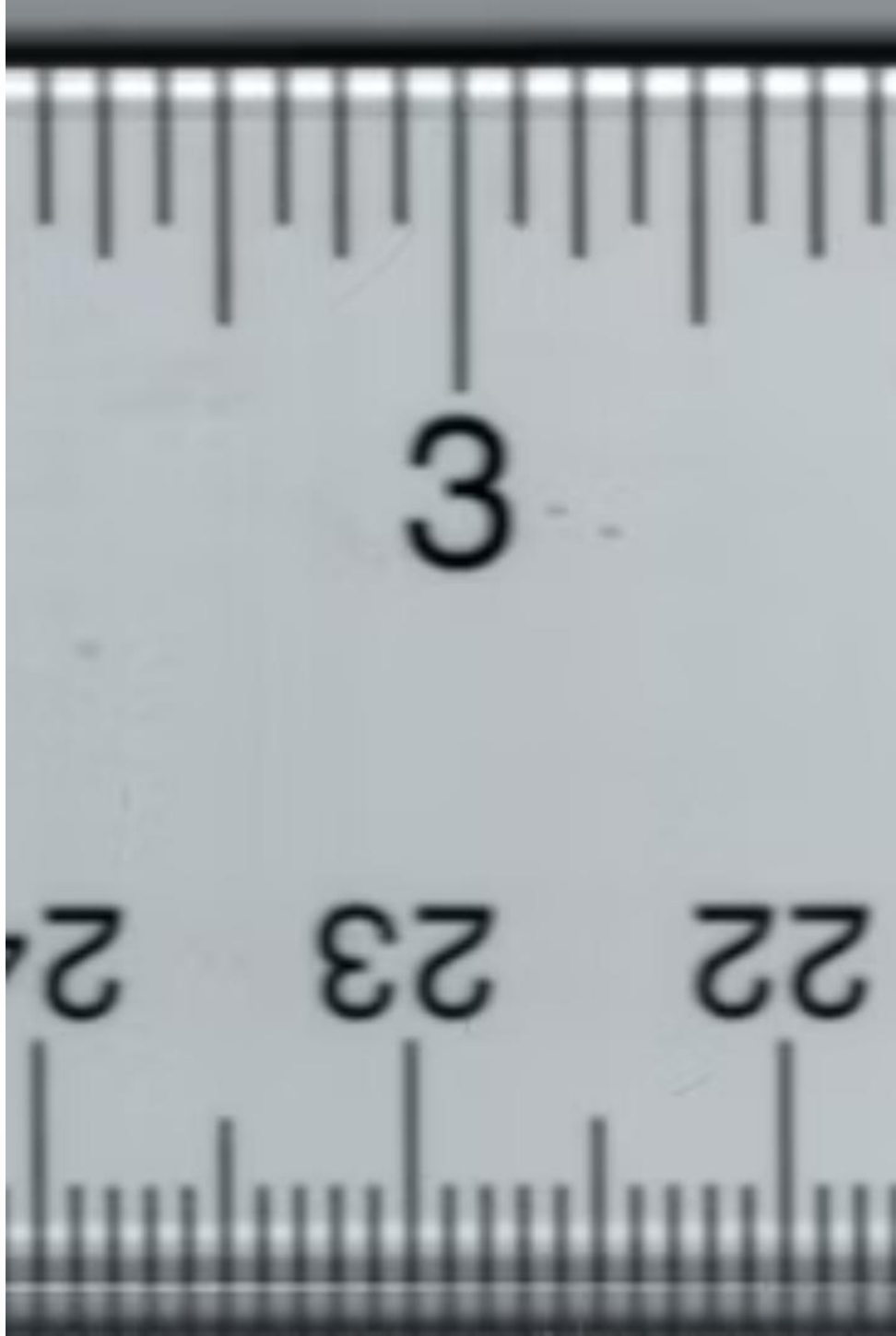
### Inches to Millimeters

Multiply inches by 25.4 to obtain millimeters

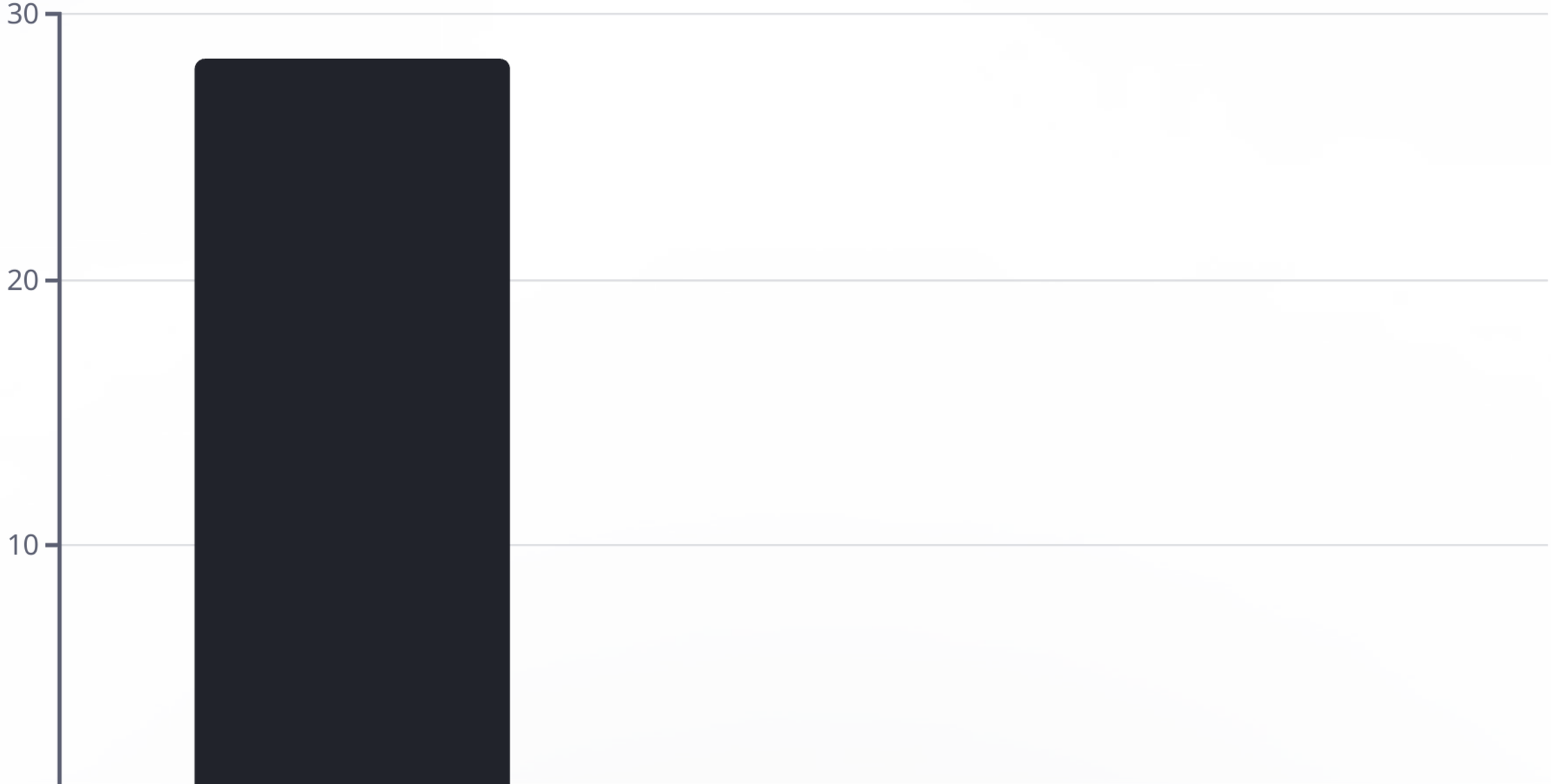
## 0.3048

### Feet to Meters

Multiply feet by 0.3048 to obtain meters



# Volume Conversion Factors



# Liquid Volume Conversion Factors

## Imperial Gallon to Liters

1 gallon = 4.546 liters

To convert gallons to liters, multiply by 4.546

## U.S. Gallon to Liters

1 U.S. gallon = 3.785 liters

To convert U.S. gallons to liters, multiply by 3.785

to Convert Horsepower to Watt

**Horsepower to Watts**

× 745.699872 = 5 hp(I) × 745.699872 = 3

**epower to Watts**

) × 746 = 10 hp(E) × 746 = 7460W

**power to Watts**

I) × 735.49875 = 10 hp(M) × 735.49875 =

**power to Watts**

) × 9809.5 = 10 hp(S) × 9809.5 = 98,095W

www.jackery.com

# Power Conversion Factors

## 745.699

Horsepower to Watts

Multiply HP by 745.699 to obtain W

## 0.2778

MJ/h to kW

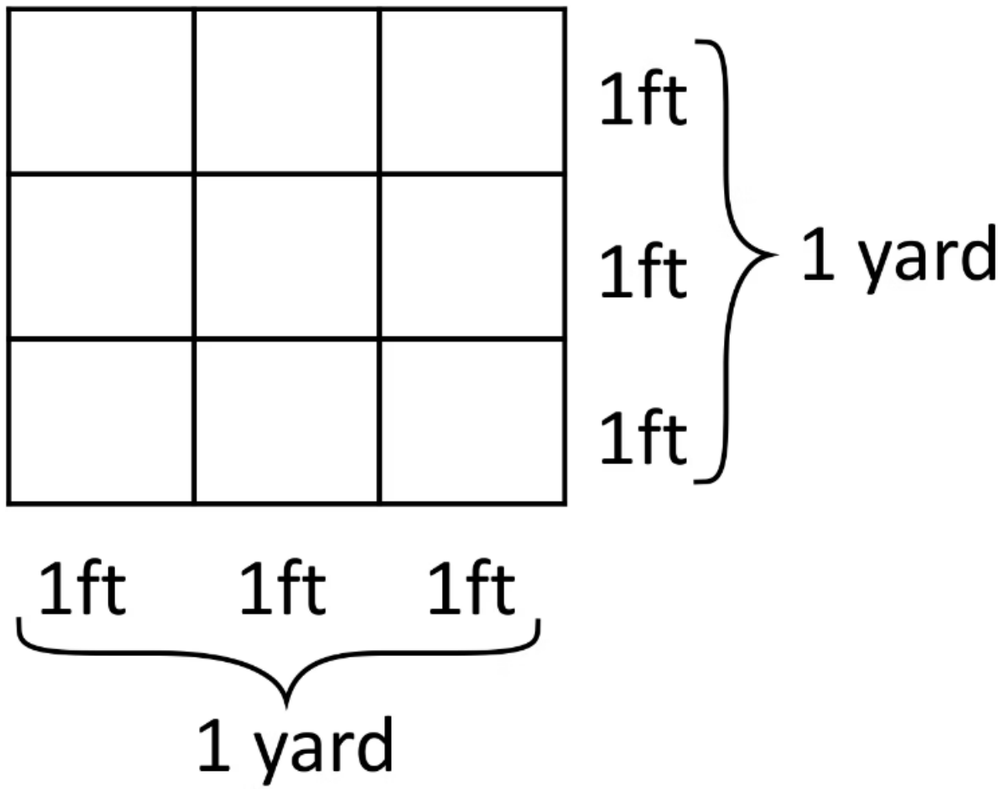
Multiply MJ/h by 0.2778 to obtain kW

# Area Conversion Factors

## Square Inches to Square Millimeters

$1\ in^2 = 645.16\ mm^2$

To convert square inches to square millimeters, multiply by 645.16




Example: $2\ in^2 = 2 \times 645.16 = 1290.32\ mm^2$

# Pressure Conversion Factors

## Inches w.c. to Pascals

Multiply by 249

## Inches w.c. to Kilopascals

Multiply by 0.249

## PSIG to Kilopascals

Multiply by 6.894757

# Mass Conversion Factors

## Ounces to Grams

1 oz = 28.35 g

To convert ounces to grams, multiply by 28.35

## Pounds to Grams

1 lb = 453.6 g

To convert pounds to grams, multiply by 453.6

# Heat Value Conversion Factors

### Btu/ft$^3$ to MJ/m$^3$

Multiply by 0.03723

### Btu/h to kW

Multiply by 0.00029295

## m to btu Conversion

| us therm | btu | us therm | btu |
|---|---|---|---|
| 20 | 2.0000e+6 | 140 | 1.4000e+7 |
| 30 | 3.0000e+6 | 160 | 1.6000e+7 |
| 40 | 4.0000e+6 | 180 | 1.8000e+7 |
| 50 | 5.0000e+6 | 200 | 2.0000e+7 |
| 60 | 6.0000e+6 | 250 | 2.5000e+7 |
| 70 | 7.0000e+6 | 300 | 3.0000e+7 |
| 80 | 8.0000e+6 | 350 | 3.5000e+7 |
| 90 | 9.0000e+6 | 400 | 4.0000e+7 |
| 100 | 1.0000e+7 | 450 | 4.5000e+7 |
| 120 | 1.2000e+7 | 500 | 5.0000e+7 |

Ex Examples.com

# Temperature Conversion

## Understand the Formula

(°F-32) × 5/9 = °C

## Subtract 32

First subtract 32 from the Fahrenheit temperature

## Multiply by 5/9

Then multiply the result by 5/9 to get Celsius

$$F = 1.8C + 32$$

| °C | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|
| °F | 66.2 | 68 | 69.8 | 71.6 | 73.4 | 75.2 | 77 | 78.8 |

| °C | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|---|---|---|---|---|---|---|---|---|
| °F | 50 | 68 | 86 | 104 | 122 | 140 | 158 | 176 |

which temperature has the same value in °F and °C ?

# Temperature Conversion Examples

| Fahrenheit (°F) | Calculation | Celsius (°C) |
|---|---|---|
| 32°F | (32-32) × 5/9 = 0 | 0°C |
| 68°F | (68-32) × 5/9 = 20 | 20°C |
| 212°F | (212-32) × 5/9 = 100 | 100°C |

# Practical Application: Converting Length

### Identify the Measurement

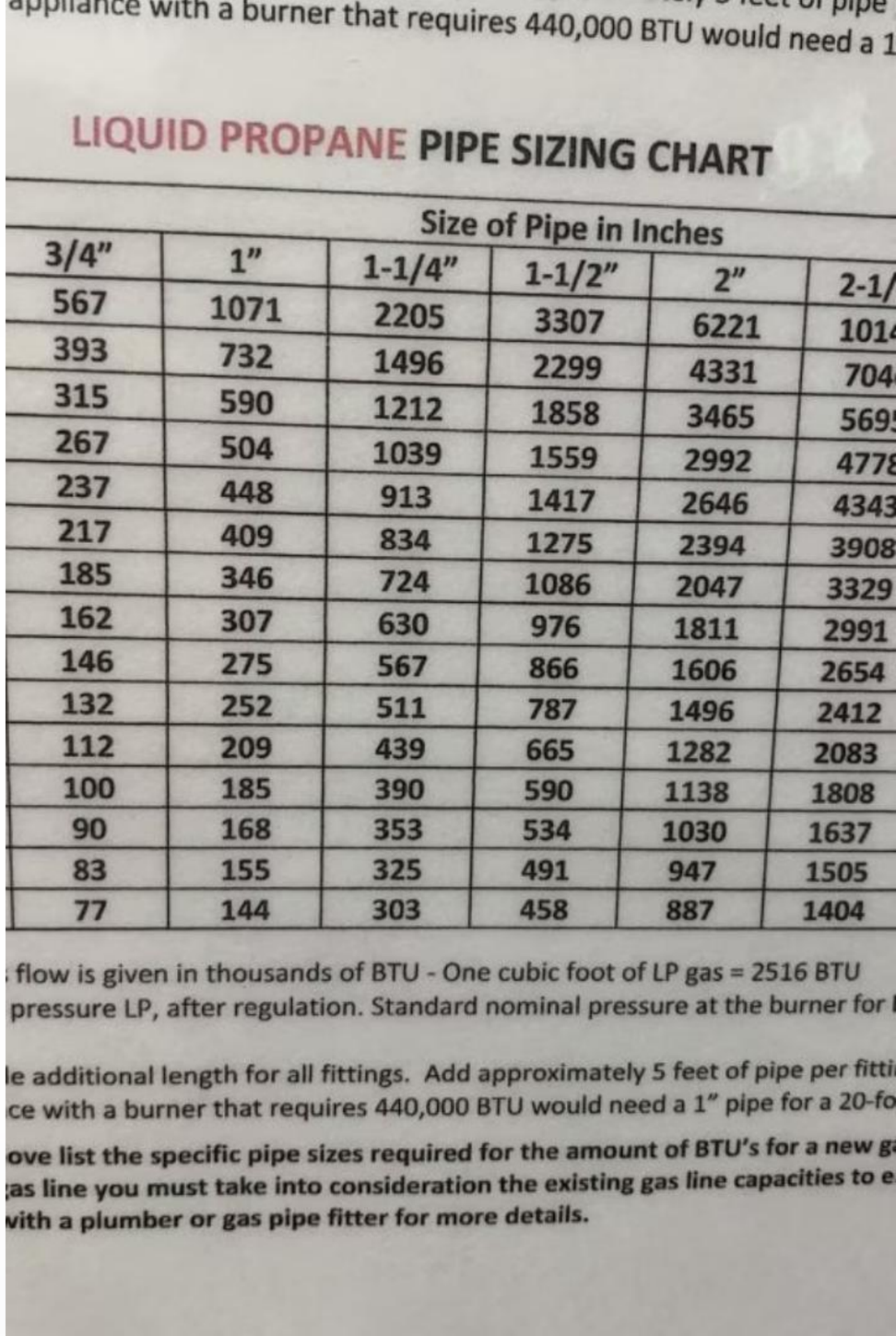
A gas pipe is specified as 24 inches long in an imperial measurement manual

### Find the Conversion Factor

From the conversion table: 1 inch = 25.4 mm

### Calculate the Conversion

24 inches × 25.4 = 609.6 mm or 60.96 cm



appliance with a burner that requires 440,000 BTU would need a 1

LIQUID PROPANE PIPE SIZING CHART

| Size of Pipe in Inches | | | | | |
|---|---|---|---|---|---|
| 3/4" | 1" | 1-1/4" | 1-1/2" | 2" | 2-1/ |
| 567 | 1071 | 2205 | 3307 | 6221 | 101 |
| 393 | 732 | 1496 | 2299 | 4331 | 704 |
| 315 | 590 | 1212 | 1858 | 3465 | 569 |
| 267 | 504 | 1039 | 1559 | 2992 | 477 |
| 237 | 448 | 913 | 1417 | 2646 | 4343 |
| 217 | 409 | 834 | 1275 | 2394 | 3908 |
| 185 | 346 | 724 | 1086 | 2047 | 3329 |
| 162 | 307 | 630 | 976 | 1811 | 2991 |
| 146 | 275 | 567 | 866 | 1606 | 2654 |
| 132 | 252 | 511 | 787 | 1496 | 2412 |
| 112 | 209 | 439 | 665 | 1282 | 2083 |
| 100 | 185 | 390 | 590 | 1138 | 1808 |
| 90 | 168 | 353 | 534 | 1030 | 1637 |
| 83 | 155 | 325 | 491 | 947 | 1505 |
| 77 | 144 | 303 | 458 | 887 | 1404 |

flow is given in thousands of BTU - One cubic foot of LP gas = 2516 BTU
pressure LP, after regulation. Standard nominal pressure at the burner for

le additional length for all fittings. Add approximately 5 feet of pipe per fitti
ce with a burner that requires 440,000 BTU would need a 1" pipe for a 20-fo

ove list the specific pipe sizes required for the amount of BTU's for a new g
as line you must take into consideration the existing gas line capacities to e
with a plumber or gas pipe fitter for more details.

# Practical Application: Converting Pressure

## Identify the Measurement

A gas regulator is set to 7 inches w.c. in an imperial specification

## Find the Conversion Factor

From the conversion table: 1 inch w.c. = 0.249 kPa

## Calculate the Conversion

7 inches w.c. × 0.249 = 1.743 kPa

## Pressure Conversion Chart

| Pressure Units | psi | kPa | inches of Hg | inches of H20 | atmospheres | bar |
|---|---|---|---|---|---|---|
| **psi** | 1 | 6.894 | 2.036 | 27.681 | .0681 | .06895 |
| **kPa** | 0.1450 | 1 | .2953 | 4.0147 | .009669 | .01 |
| **inches of Hg** | 0.4912 | 3.3864 | 1 | 13.595 | .03342 | .03386 |
| **inches of $H^2O$** | 0.03613 | .2491 | .07355 | 1 | .002458 | .002491 |
| **atmospheres** | 14.696 | 101.33 | 29.92 | 406.8 | 1 | 1.0133 |
| **bar** | 14.504 | 100 | 29.53 | 401.86 | .9869 | 1 |

**Ball Parking**

1 psi = 7 kPa

1 inch Hg = 0.5 psi

100 inch H20 = 3.5 psi

**1 Bar = 1 Atmos = 14.7 psi**

**Accurate**

1 psi = 6.89 kPa

1 inch Hg = 0.49 psi

100 inch H20 = 3.61 psi

**1 Bar = 14.5 psi = 100 kPa**

# Practical Application: Converting Heat Value

## Identify the Measurement

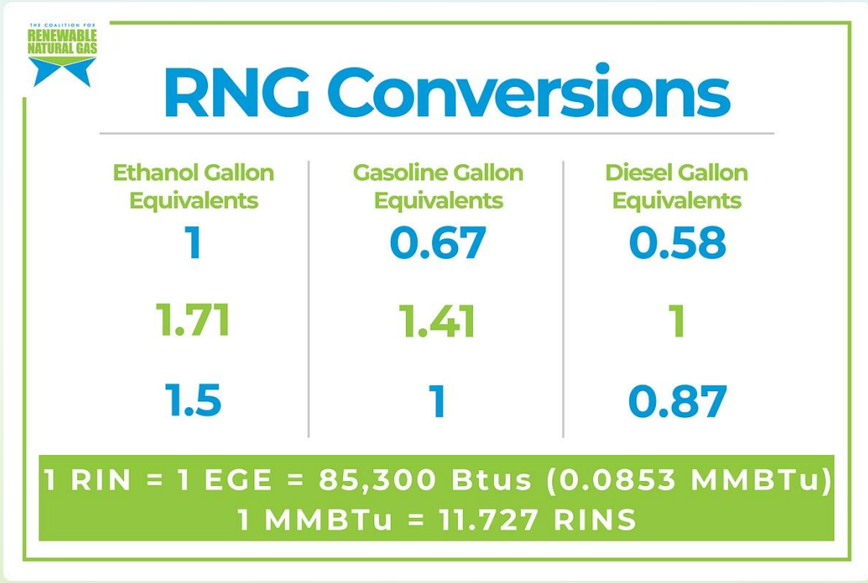
Natural gas has a heating value of 1,000 Btu/$ft^3$

## Find the Conversion Factor

From the conversion table: 1 Btu/$ft^3$ = 0.03723 MJ/$m^3$

## Calculate the Conversion

1,000 Btu/$ft^3$ × 0.03723 = 37.23 MJ/$m^3$



# Practical Application: Converting Flow Rate

### Identify the Measurement

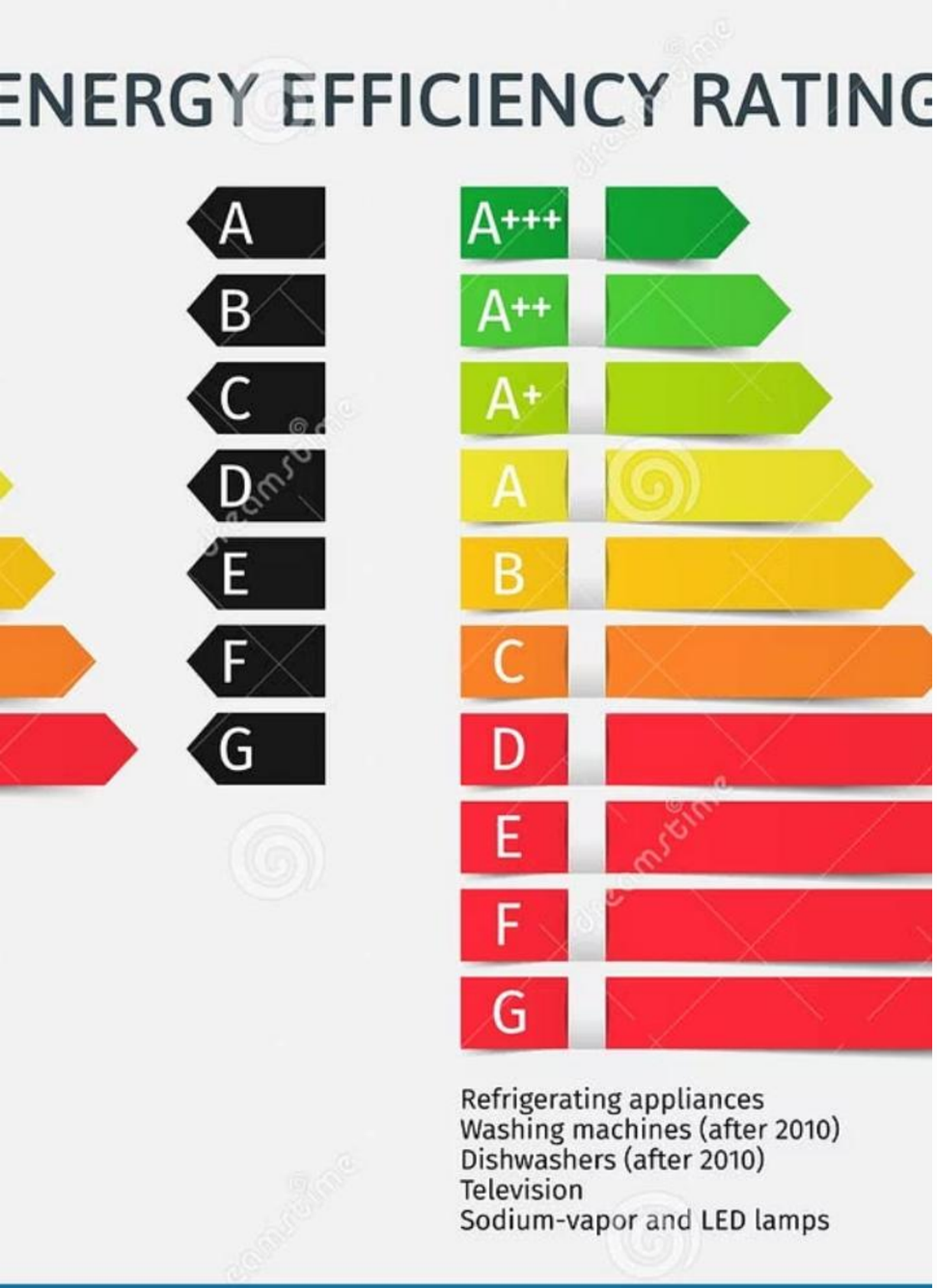
A gas appliance requires 100 $ft^3/h$ of gas

### Find the Conversion Factor

From the conversion table: 1 $ft^3/h$ = 0.028328 $m^3/h$

### Calculate the Conversion

100 $ft^3/h \times 0.028328 = 2.8328\ m^3/h$




# Practical Application: Converting Power

## Identify the Measurement

A gas furnace is rated at 80,000 Btu/h

## Find the Conversion Factor

From the conversion table: 1 Btu/h = 0.00029295 kW

## Calculate the Conversion

80,000 Btu/h × 0.00029295 = 23.436 kW

# Summary of Key Conversion Factors

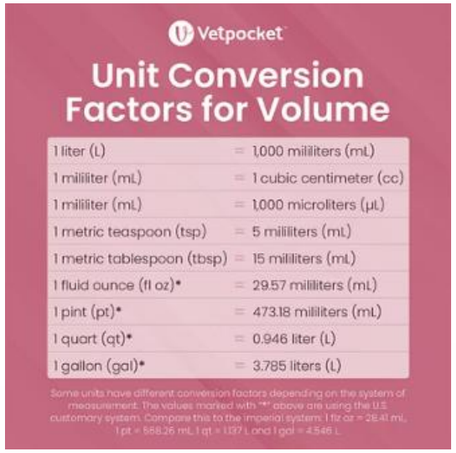
This metric conversion table contains APPROXIMATE factors. Most are NOT EXACT

APPROXIMATE CONVERSIONS FROM SI/METRIC UNITS TO STANDARD/US CUSTOMARY UNITS

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND | SYMBOL |
|---|---|---|---|---|
| | LENGTH | | | |
| mm | millimeters | 0.039 | inches | in |
| m | meters | 3.28 | feet | ft |
| m | meters | 1.09 | yards | yd |
| km | kilometers | 0.621 | miles | mi |
| | AREA | | | |
| mm² | millimeters | 0.0016 | square inches | in² |
| m² | square meters | 10.764 | square feet | ft² |
| m² | square meters | 1.195 | square yards | yd² |
| ha | hectares | 2.47 | acres | ac |
| km² | square kilometers | 0.386 | square miles | mi² |
| | VOLUME | | | |
| mL | milliliters | 0.034 | fluid ounces | fl oz |
| L | liters | 0.264 | gallons | gal |
| m³ | cubic meters | 35.314 | cubic feet | ft³ |
| m³ | cubic meters | 1.307 | cubic yards | yd³ |
| | MASS | | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.202 | pounds | lb |
| Mg (or "t") | megagrams (or "metric ton") | 1.103 | short tons (2000 lb) | T |
| | TEMPERATURE | | | |
| °C | Celsius | 1.8C + 32 | Fahrenheit | °F |
| | ILLUMINATION | | | |
| lx | lux | 0.0929 | foot-candles | fc |
| cd/m² | candela/m² | 0.2919 | foot-Lamberts | fl |

APPROXIMATE CONVERSIONS FROM SI/METRIC UNITS TO STANDARD/US CUSTOMARY UNITS

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND | SYMBOL |
|---|---|---|---|---|
| | LENGTH | | | |
| mm | millimeters | 0.039 | inches | in |
| m | meters | 3.28 | feet | ft |
| m | meters | 1.09 | yards | yd |
| km | kilometers | 0.621 | miles | mi |
| | AREA | | | |
| mm² | millimeters | 0.0016 | square inches | in² |
| m² | square meters | 10.764 | square feet | ft² |
| m² | square meters | 1.195 | square yards | yd² |
| ha | hectares | 2.47 | acres | ac |
| km² | square kilometers | 0.386 | square miles | mi² |
| | VOLUME | | | |
| mL | milliliters | 0.034 | fluid ounces | fl oz |
| L | liters | 0.264 | gallons | gal |
| m³ | cubic meters | 35.314 | cubic feet | ft³ |
| m³ | cubic meters | 1.307 | cubic yards | yd³ |
| | MASS | | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.202 | pounds | lb |
| Mg (or "t") | megagrams (or "metric ton") | 1.103 | short tons (2000 lb) | T |
| | TEMPERATURE | | | |
| °C | Celsius | 1.8C + 32 | Fahrenheit | °F |
| | ILLUMINATION | | | |
| lx | lux | 0.0929 | foot-candles | fc |
| cd/m² | candela/m² | 0.2919 | foot-Lamberts | fl |

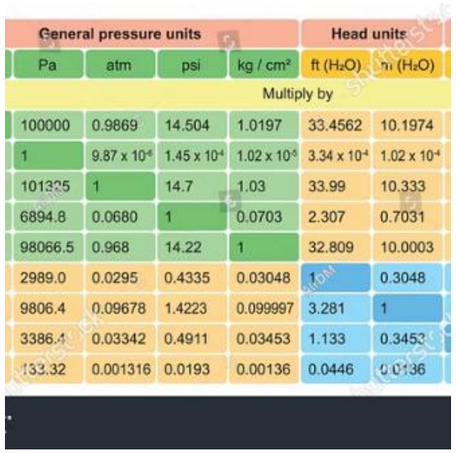


Vetpocket

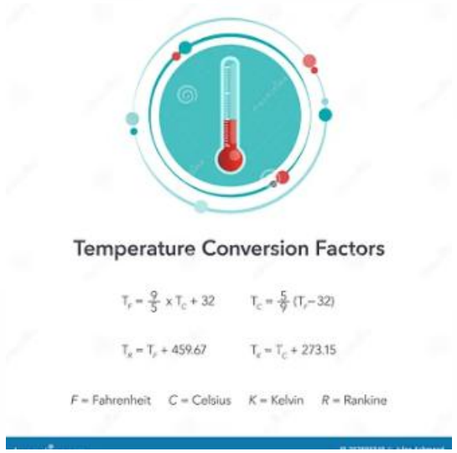
## Unit Conversion Factors for Volume

| | | |
|---|---|---|
| 1 liter (L) | = | 1,000 milliliters (mL) |
| 1 milliliter (mL) | = | 1 cubic centimeter (cc) |
| 1 milliliter (mL) | = | 1,000 microliters (µL) |
| 1 metric teaspoon (tsp) | = | 5 milliliters (mL) |
| 1 metric tablespoon (tbsp) | = | 15 milliliters (mL) |
| 1 fluid ounce (fl oz)* | = | 29.57 milliliters (mL) |
| 1 pint (pt)* | = | 473.18 milliliters (mL) |
| 1 quart (qt)* | = | 0.946 liter (L) |
| 1 gallon (gal)* | = | 3.785 liters (L) |

Some units have different conversion factors depending on the system of measurement. The values marked with "*" above are using the U.S. customary system. Compare this to the Imperial system: 1 fl oz = 28.41 mL, 1 pt = 568.26 mL, 1 qt = 1.137 L, and 1 gal = 4.546 L.



| General pressure units | | | | Head units | |
|---|---|---|---|---|---|
| Pa | atm | psi | kg / cm² | ft ($H_2O$) | m ($H_2O$) |
| Multiply by | | | | | |
| 100000 | 0.9869 | 14.504 | 1.0197 | 33.4562 | 10.1974 |
| 1 | 9.87 x $10^{-6}$ | 1.45 x $10^{-4}$ | 1.02 x $10^{-5}$ | 3.34 x $10^{-4}$ | 1.02 x $10^{-4}$ |
| 101325 | 1 | 14.7 | 1.03 | 33.99 | 10.333 |
| 6894.8 | 0.0680 | 1 | 0.0703 | 2.307 | 0.7031 |
| 98066.5 | 0.968 | 14.22 | 1 | 32.809 | 10.0003 |
| 2989.0 | 0.0295 | 0.4335 | 0.03048 | 1 | 0.3048 |
| 9806.4 | 0.09678 | 1.4223 | 0.099997 | 3.281 | 1 |
| 3386.4 | 0.03342 | 0.4911 | 0.03453 | 1.133 | 0.3453 |
| 133.32 | 0.001316 | 0.0193 | 0.00136 | 0.0446 | 0.0136 |

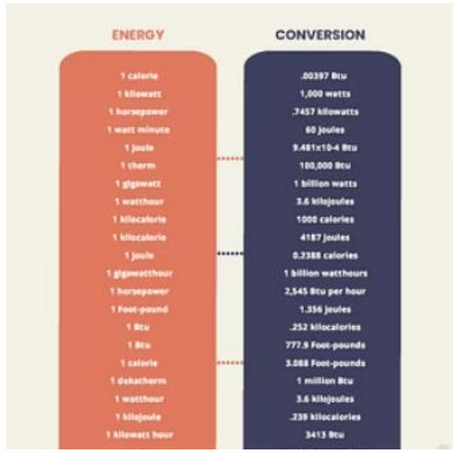


## Temperature Conversion Factors

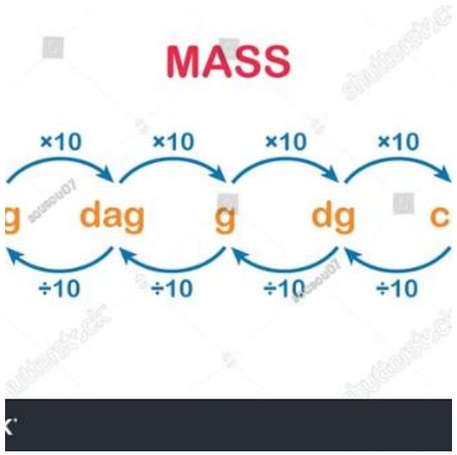
$T_F = \frac{9}{5} \times T_C + 32$ $T_C = \frac{5}{9}(T_F - 32)$

$T_K = T_F + 459.67$ $T_K = T_C + 273.15$

*F* = Fahrenheit *C* = Celsius *K* = Kelvin *R* = Rankine



| ENERGY | CONVERSION |
|---|---|
| 1 calorie | .00397 Btu |
| 1 kilowatt | 1,000 watts |
| 1 horsepower | .7457 kilowatts |
| 1 watt minute | 60 joules |
| 1 joule | 9.481x10-4 Btu |
| 1 therm | 100,000 Btu |
| 1 gigawatt | 1 billion watts |
| 1 watthour | 3.6 kilojoules |
| 1 kilocalorie | 1000 calories |
| 1 kilocalorie | 4187 joules |
| 1 joule | 0.2388 calories |
| 1 gigawatthour | 1 billion wattheurs |
| 1 horsepower | 2,545 Btu per hour |
| 1 Foot-pound | 1.356 joules |
| 1 Btu | .252 kilocalories |
| 1 Btu | 777.9 Foot-pounds |
| 1 calorie | 3.088 Foot-pounds |
| 1 dekatherm | 1 million Btu |
| 1 watthour | 3.6 kilojoules |
| 1 kilojoule | .239 kilocalories |
| 1 kilowatt hour | 3413 Btu |



# Importance of Accurate Conversions

## Safety

Prevents hazardous conditions from incorrect specifications

## Performance

Ensures equipment operates at intended capacity

## Compliance

Meets regulatory requirements and code standards

## Efficiency

Optimizes system operation and energy usage