CSA Unit 2 - Fasteners: Chapter 1
Choosing the Right Hardware for Gas Technicians

This presentation will guide gas technicians and fitters in selecting the correct fasteners for various applications. We'll explore different types of fasteners, their proper usage, and important safety considerations to ensure secure installations.

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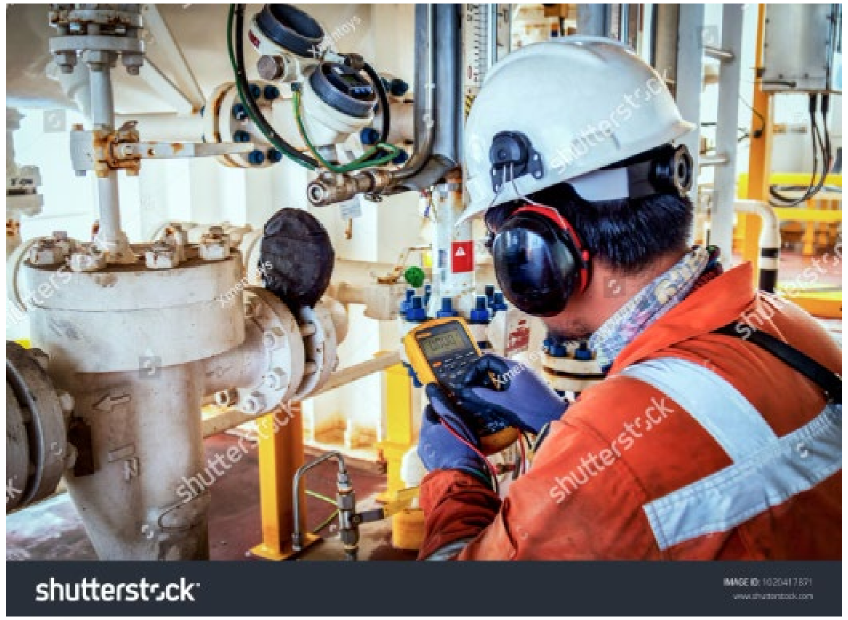
Created
by Mike Kapin

Purpose and Objectives

Purpose

To enable the gas technician/fitter to choose the correct fastener for the job.



Objectives

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

- identify the methods for selecting and securing correct fasteners
- identify types of fasteners

Key Terminology

Fastener

A device that attaches something firmly to something else.

Understanding the proper terminology is essential for gas technicians to communicate effectively and select the right components for each job.

Requirements for Using Fasteners

Material Type

Type of material to which you must fasten the piping or equipment

Equipment Type

Type of equipment that you are fastening

Weight and Shape

Weight and shape of the equipment

Support Direction

Whether the equipment has support from above or below

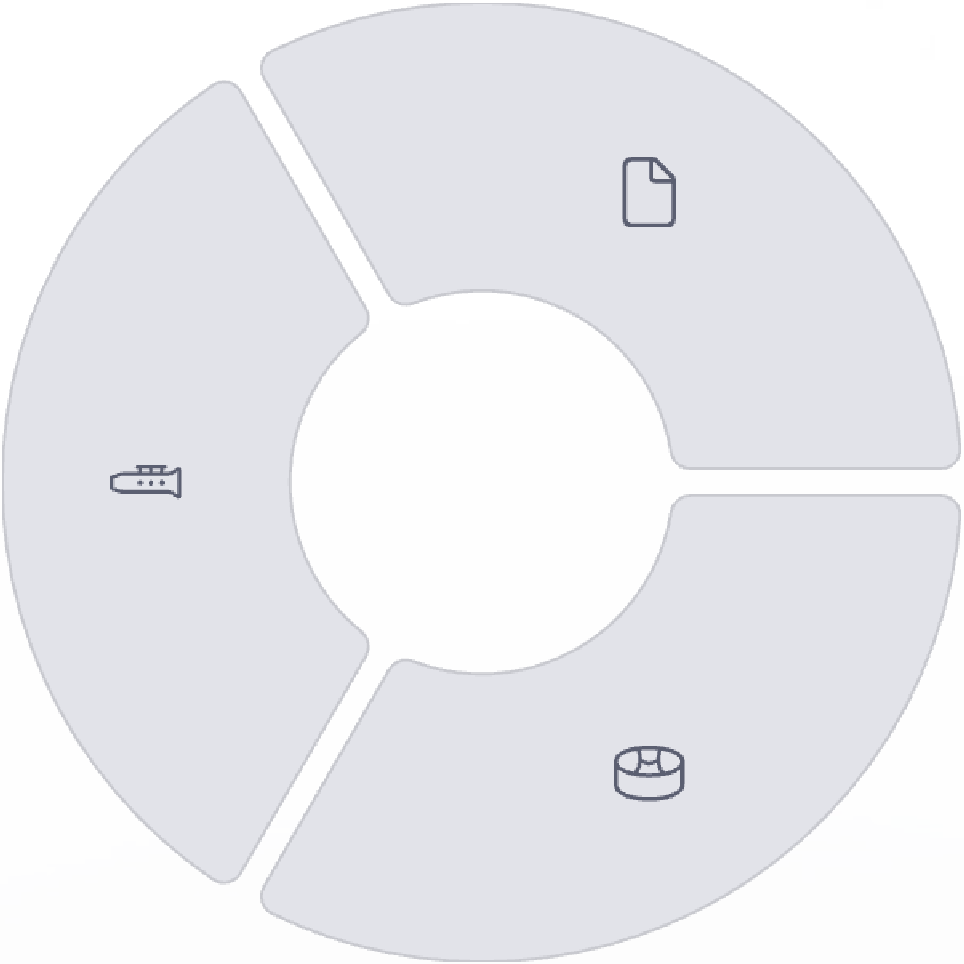
Movement Factors

Whether expansion or vibration is a factor

Quantity Needed

The number of fasteners or supports required

Main Materials in Gas Industry



Wood

Requires specific fasteners like wood screws and lag bolts

Concrete

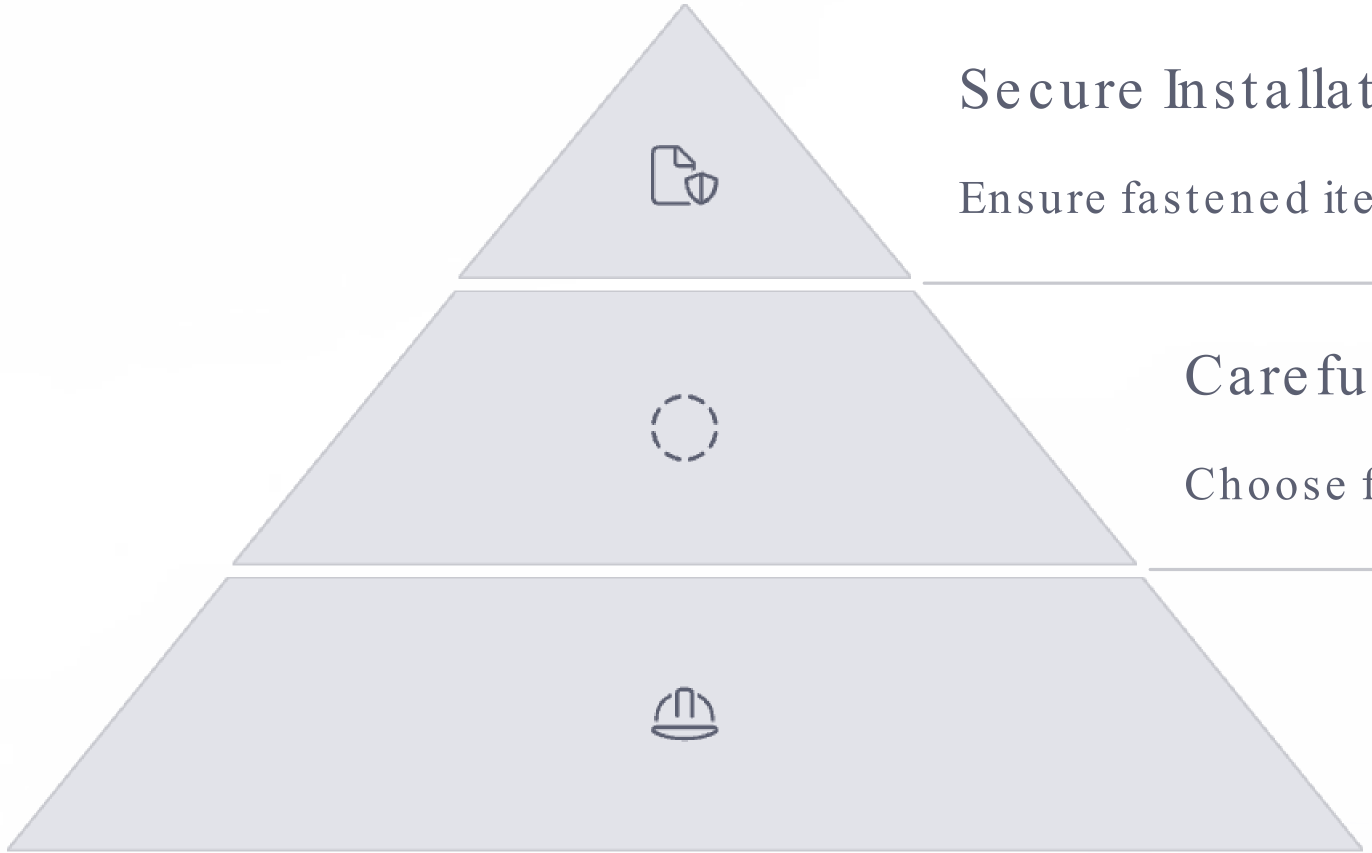
Requires anchors, shields, and specialized fastening techniques

Steel

Requires metal screws, bolts, and specialized clamps

In the gas industry, these three main types of material are what you must fasten to or from.

Safety and Security Considerations



Secure Installation

Ensure fastened items remain in original position

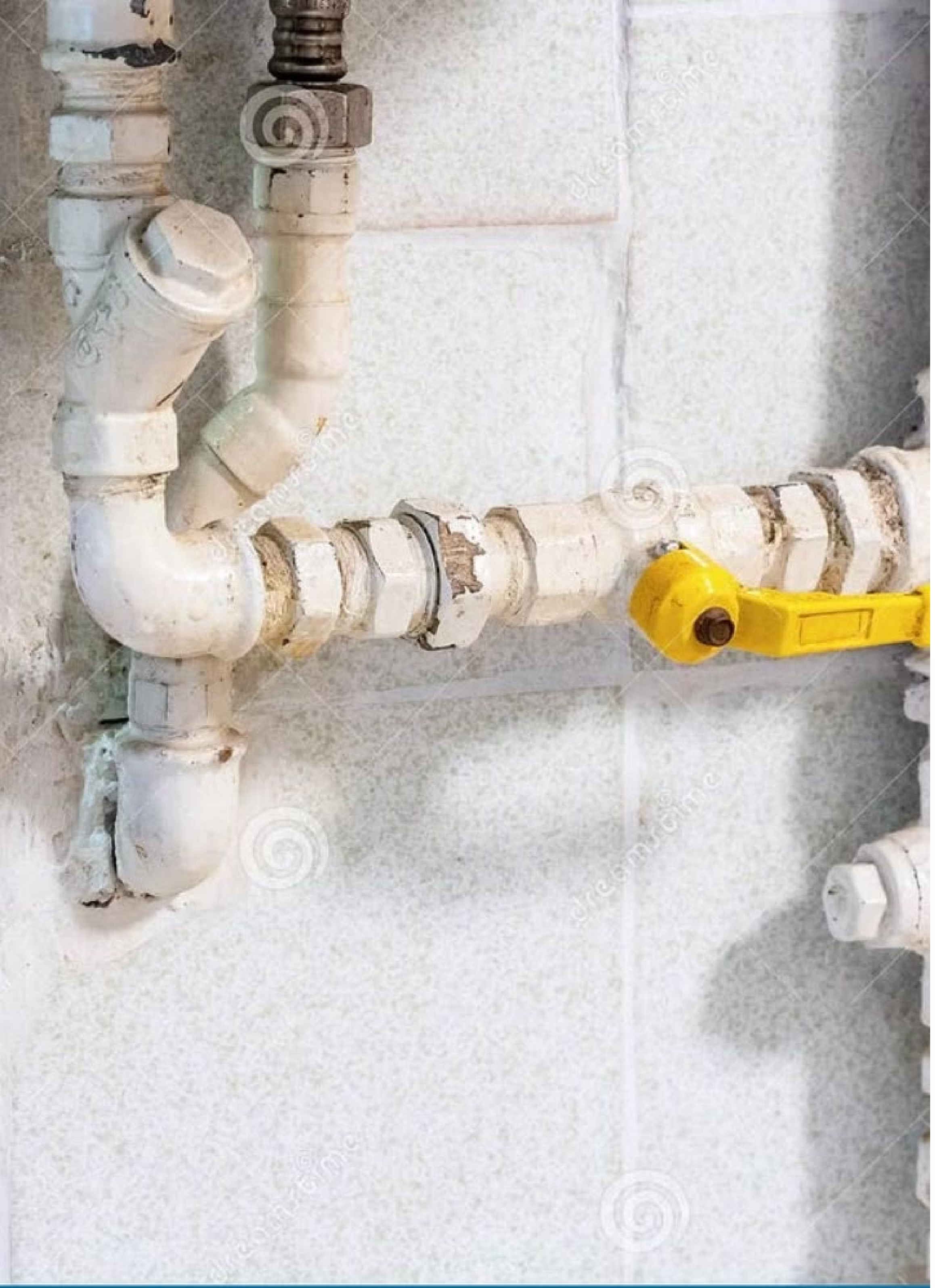
Careful Selection

Choose fastening devices and supports with care

Safety First

Carry out fastening safely and securely

It is important that you make sure you carry out the fastening of piping or equipment safely and securely. It is essential that anything you fasten remains in its original position. You should select a fastening device or design of a support or bracket with care.



Ensuring Secure Installations

Select Correct Size and Grade

Choose screws or bolts of the correct size and grade for the application.

Use Proper Inserts and Plugs

Select the correct inserts, plugs, and shields that you must drill or place in concrete, and set them properly.

Account for Movement

Consider expansion, contraction, and vibration, and take appropriate measures to ensure the piping or equipment remains in place.

Use Adequate Support

Use the proper number of fasteners and supports for the weight or size of the piping and equipment.

General Fasteners Overview

Variety of Options

A huge variety of fasteners is available to the gas technician/fitter. Their designs are job-specific, so you must take care in selecting them.

Attention to Detail

Small details can have a great effect on their function. Be sure to store all fasteners in a clean and dry environment once purchased.

Types of Screws

Wood Screws

Used for fastening to wooden materials

Metal Screws

Used for fastening to metal surfaces

Machine Screws

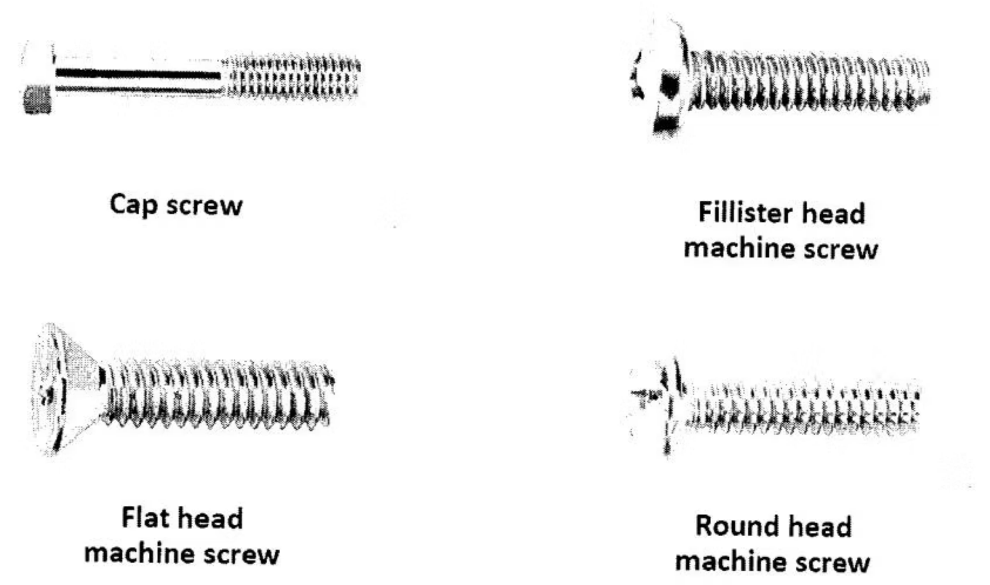
Used with nuts or in threaded holes

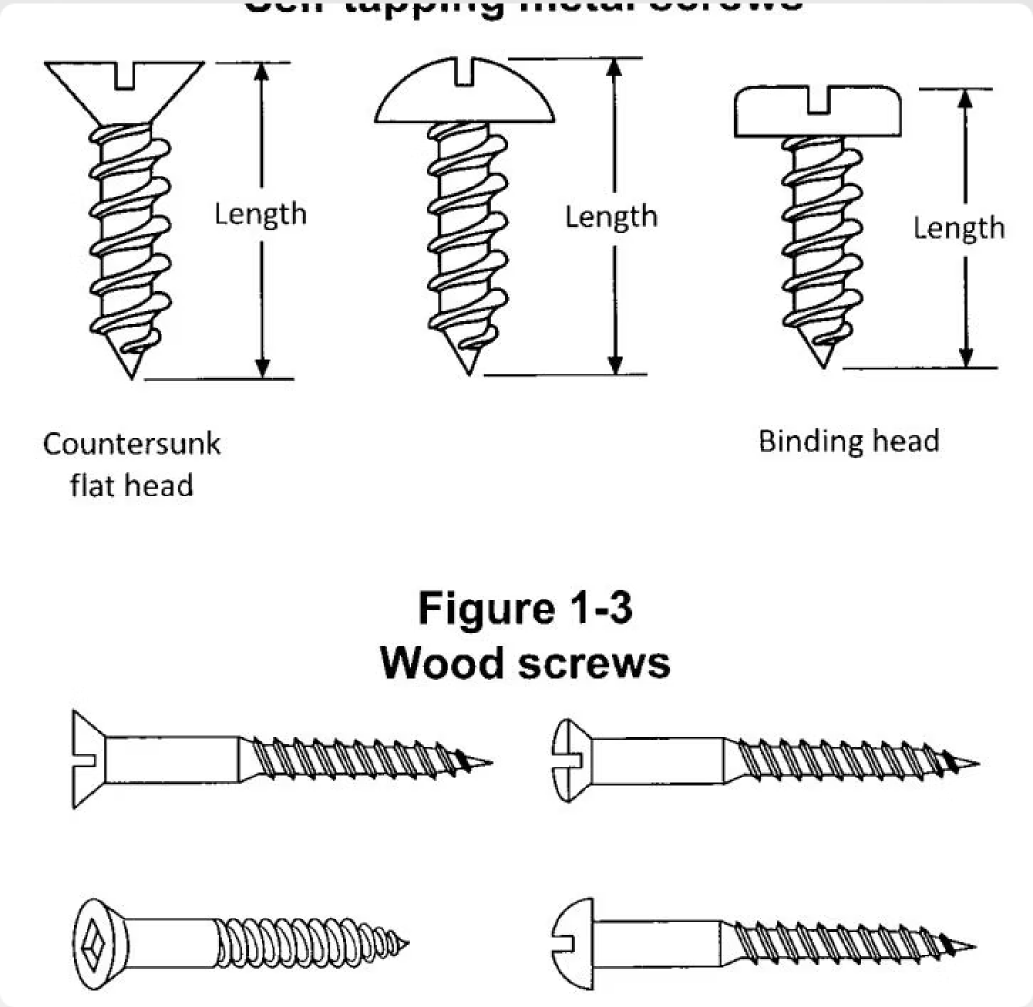
Set Screws

Used to prevent movement between parts

There are many different types of screws, which come in varying sizes, lengths, and head types, but have one purpose - to fasten one object to another. Gas technicians/fitters extensively use all types.

Figure 1-1
Various types of screws
Image courtesy of DeWalt





Self-Tapping Metal Screws

Purpose

Create their own threads as they are driven into material

Applications

Commonly used for sheet metal and thin materials

Advantages

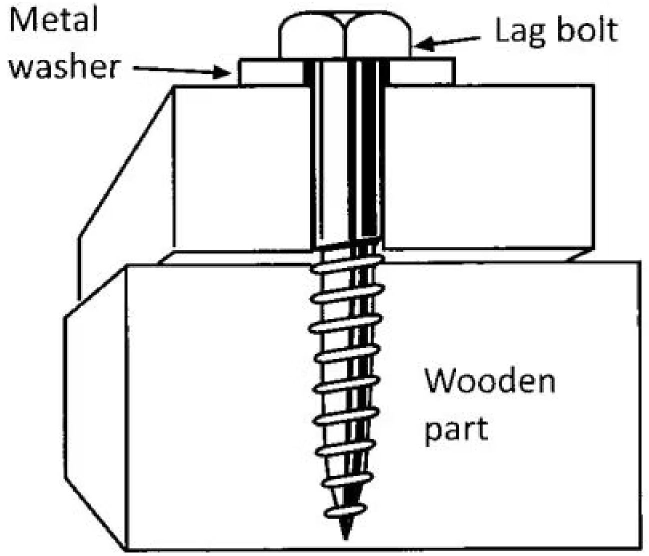
No need for pre-tapping or nuts

Varieties

Available in different head styles and thread patterns

Lag Bolts

Figure 1-4
Lag bolt



Definition

Lag bolts are not actually bolts; they are heavy screws that help fasten brackets to wooden members.

Applications

They are a practical alternative to a nut and bolt arrangement, although larger sizes of lag bolts may require a pilot hole.

Usage in Gas Industry

Commonly used for securing heavy equipment and brackets to wooden structural members.

Bolts and Nuts

Varieties

Bolts are available in various lengths, sizes, and configurations. They fasten objects into a set position by the leverage of the thread.

Thread Types

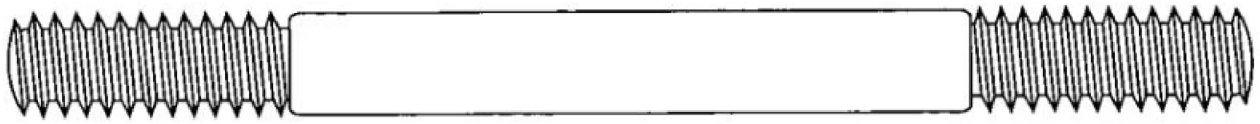
The thread on the bolt can be either National Fine (NF) or the more commonly used National Coarse (NC).

Measurement

Gas technicians/fitters measure the length of bolts from underneath the head to the end in most cases and from end to end in bolts with countersunk heads.

Figure 1-5
Various bolts and nuts
Image courtesy of DeWalt

Threaded Rod



Purpose

Often, the use of a manufactured bolt is not realistic because the correct length is not available, and adjustments are limited. In such cases, you can use a threaded rod and cut it to the required length.

Types

- Steel rod with threaded ends
- All-threaded rod

Applications

Commonly used for custom length fastening solutions in gas installations.

Anchoring Fasteners

Purpose

Various devices help fasten hangers and supports to concrete walls and ceilings.

Materials

They may be iron, lead, or plastic.

Applications

Essential for securing gas equipment to concrete structures.

Insert Anchors and Shields

Insert Anchors

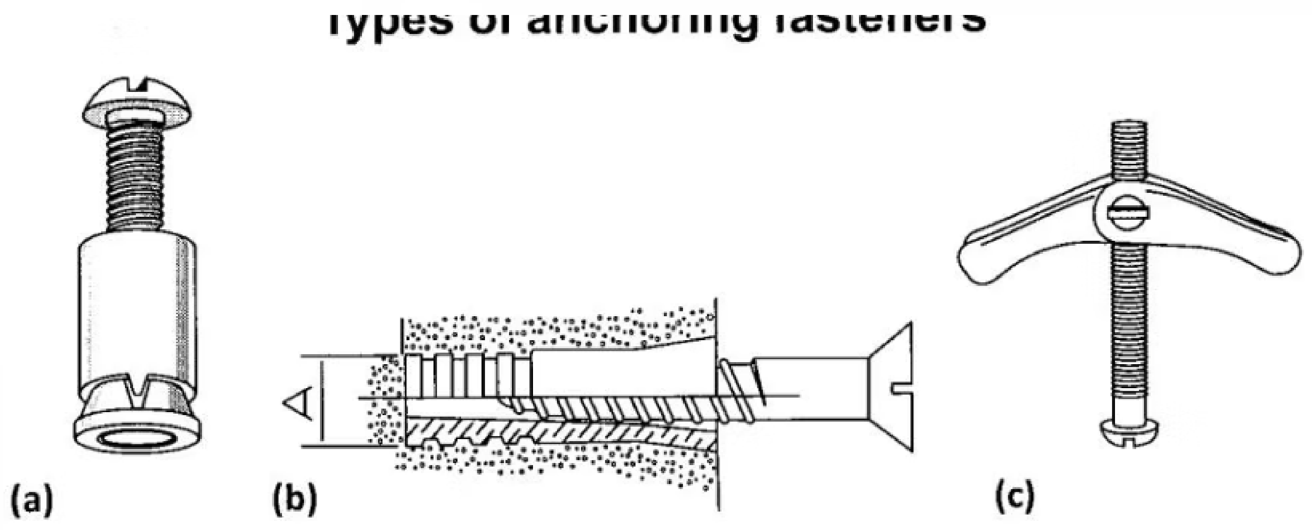
Gas technicians/fitters use insert anchors with machine bolts or lag screws. They insert the anchor into the hole and tighten the fastener into the shield.

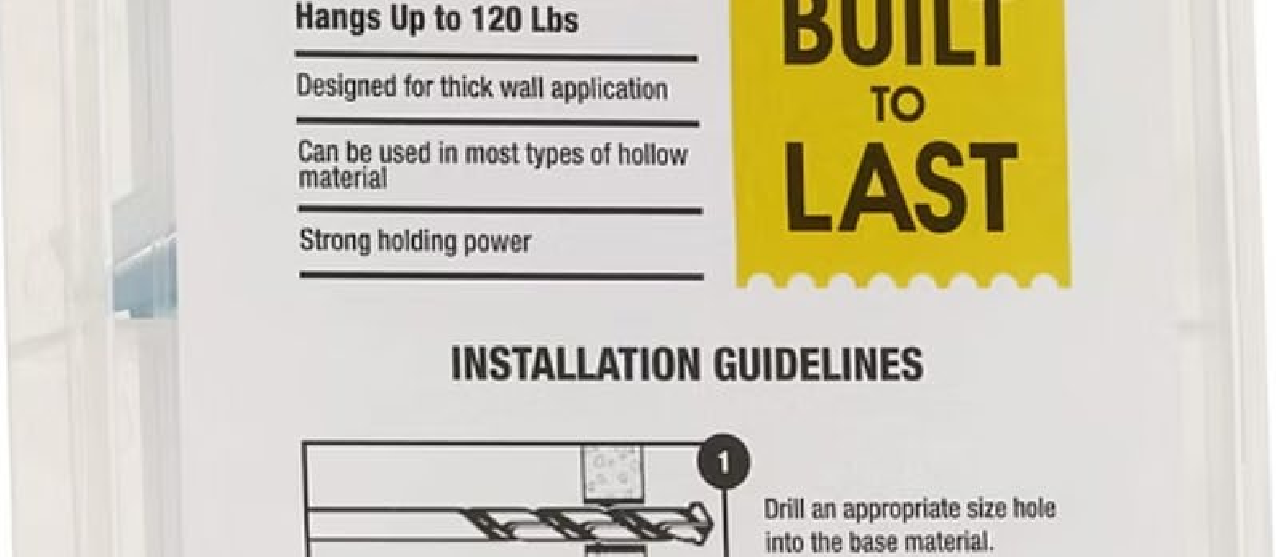
Lead and Plastic Shields

Also known as rawl plugs, these are used with machine bolts or lag screws. They require the drilling of a correctly sized hole into the surface.

Drop-in Anchors

Require a special tool or pin to set the anchor. The tool must be the appropriate size for the anchor, i.e., a 3/8 tool for a 3/8 anchor, and should not have a "mushroomed" end.





Toggle Bolts

Purpose

Help fix hangers to surfaces with hollow spaces behind them

Mechanism

Tightening causes bracing against back wall surface

Types

Spring wing, tumble, and riveted tumble

Toggle bolts help fix hangers to surfaces with hollow spaces behind them. The action of correctly tightening the toggle bolt causes a bracing mechanism to act against the back wall surface.

Hose Clamps

Figure 1-8 Gear type hose clamp (manual tightening)

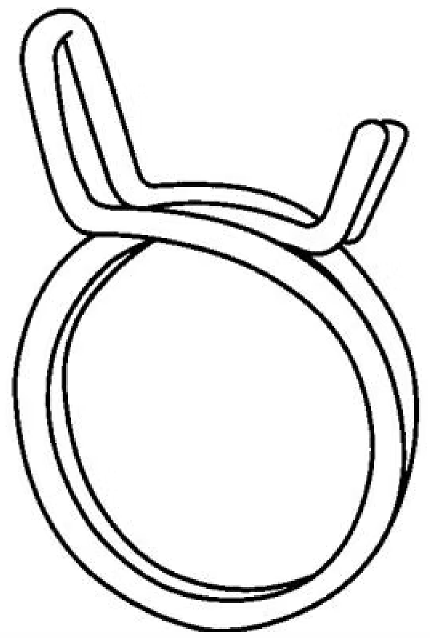


Figure 1-9 Hose clamp (self-tightening)

Purpose

Gas technicians/fitters use a hose clamp to attach a hose to a pipe, pump, or other device.

Types

Hose clamps can be of the self-tightening type (spring loaded) or of the type requiring manual tightening.

Important Note

Generally speaking, hose clamps are not approved for use with a hose that carries either natural gas or propane.

Pipe Fasteners Introduction

Importance

The installation of piping systems is an integral part of the gas trade.

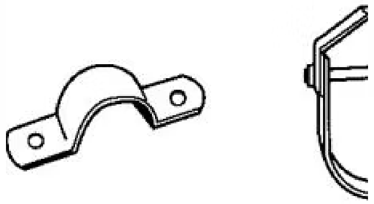
Pre-Installation Considerations

Before installation, it is important to consider how, where, and how often you must support (or fasten) a piping system from (or to) the structure.

Variety

The pipe supports and fasteners are numerous. This presentation describes some of the more common ones.

Pipe Straps



Materials

Galvanized steel, copper, cast malleable iron, and plastic.

Applications

At times, gas technicians/fitters use them on vertical and horizontal installations.

Sizes

They are available in Nominal Pipe Sizes NPS 1/2 to NPS 4.

Clevis Hangers

Material

Usually black steel.

Installation Note

For proper performance, you must tighten the hanger load nut above the clevis securely.

Applications

Commonly used for supporting horizontal pipe runs from overhead structures.

Adjustable Ring Hangers

Adjustable Steel Ring Hangers

- Zinc-plated
- Sizes range from NPS 3/4 to NPS 8

Adjustable Swivel-Ring Hangers

- Have a solid ring
- Sizes range from NPS 3/4 to NPS 8

Pipe Stays/Valley Hangers

Purpose

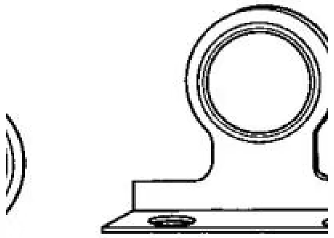
Provides support from the floor or wall.

Applications

Used when overhead support is not possible or when additional stabilization is needed.

Installation

Must be securely fastened to the supporting surface to ensure stability.



Grappling Bar

Alternative Names

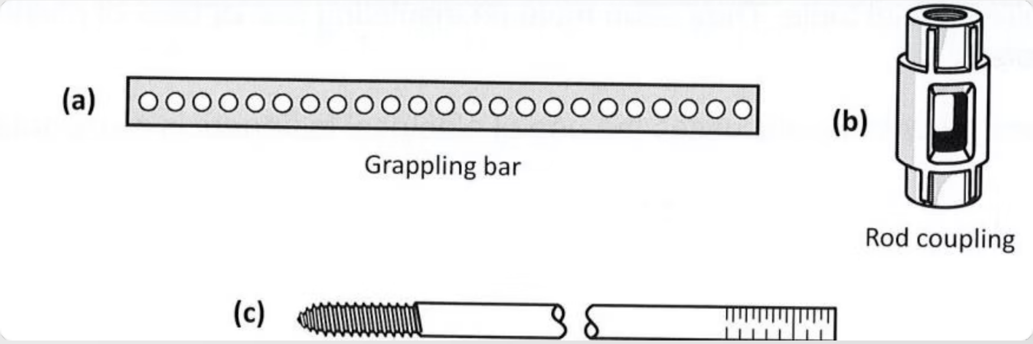
Also called an extension bar, hanger iron, strap iron, grapple iron, or perforated band iron.

Materials

Available in various thicknesses as straight lengths or coils of black and galvanized steel, and copper.

Application

You can form this into a ring-type hanger by bending it around pipe.



Threaded Rod and Rod Coupling

Purpose

Can help extend lengths where required.

Applications

Used in pipe hanging systems to achieve the correct height or length for proper support.

Installation

Must be securely connected to ensure stability and proper load distribution.

Coach-Screw and Machine-Threaded Rod

Application

Used where one end of the coach-screw can be screwed into a wood member of a building, with the hanger attached to the other end.

Availability

It is available in many dimensions and lengths.

Thread Type

The thread type is usually National Coarse (NC).

Floor and Ceiling Flanges

Popularity

Popular for attaching pipe hangers to a ceiling or high building member.

Installation

Must be securely fastened to the supporting surface using appropriate fasteners for the material.

Applications

Commonly used in gas piping systems to provide stable support points.

Beam Clamps

Purpose

Used with hanger rods to support piping from structural beams.

Advantages

Provides secure attachment without drilling or welding to structural members.

Types

Available in various configurations to accommodate different beam sizes and shapes.

Riser Clamps

Function

Vertical pipe hangers. The clamp grips the pipe, forming a solid support.

Installation Note

You may tack-weld it to steel pipe for additional security.

Applications

Essential for supporting vertical pipe runs in multi-story gas installations.

Other Pipe Support Styles

Various other styles of pipe supports are available to accommodate different installation requirements and environmental conditions. Each type has specific applications where it performs best.

Electrical Fasteners Overview

Importance

Much of today's gas equipment has electrically operated controls and components.

Connection Type

These types of fasteners enable good mechanical and electrical connection without the need for solder.

Variety

They are available in a range of sizes and shapes. Some are connected with common tools; others require special tools.

Insulation

They often have an insulating cap or boot of plastic or rubber over the conductors.

Figure 1-13
Solderless electrical connectors
Image courtesy of Terry Bell

Types of Electrical Fasteners

Wire Nuts

For connecting multiple wires together

Spade Connectors

For secure terminal connections

Ring Terminals

For connections requiring a screw fastener

Butt Connectors

For inline wire splicing

Unit 5 Introduction to Electricity discusses the use of electrical fasteners in more detail.

Sheet Metal Fasteners

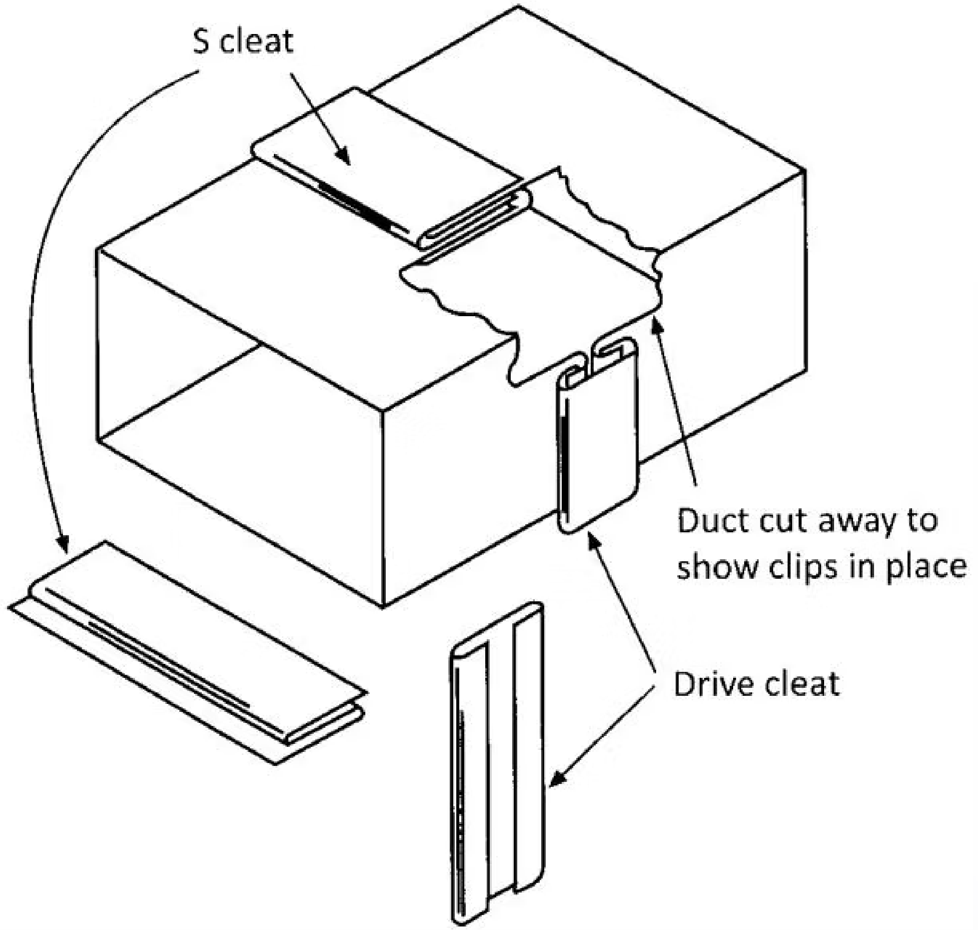
Common Types

The most common sheet metal fasteners you will encounter as a gas technician/fitter are a variety of self-tapping screws and other specialized fasteners.

Applications

Used for connecting components in gas systems and ductwork.

Figure 1-14
"S" and drive cleats



S and Drive Cleats

Purpose

For connecting sections of ductwork.

Installation

S-cleats slide over the joined edges of ductwork, while drive cleats are hammered onto the joint.

Advantages

Provides secure connection while allowing for thermal expansion and contraction.

Aluminum Tape

Purpose

Gas technicians/fitters use aluminum tape during thermal insulation of ductwork to fasten the insulation to the duct.

Availability

The tape is available in different widths.

Reinforcement

Manufacturers sometimes reinforce this with fibre threads for added strength.

Red Seal Alignment

1

Safety-Related Functions

Performs safety-related functions

2

Tools and Equipment

Maintains and uses tools and equipment

3

Planning and Preparation

Plans and prepares for installation, service and maintenance

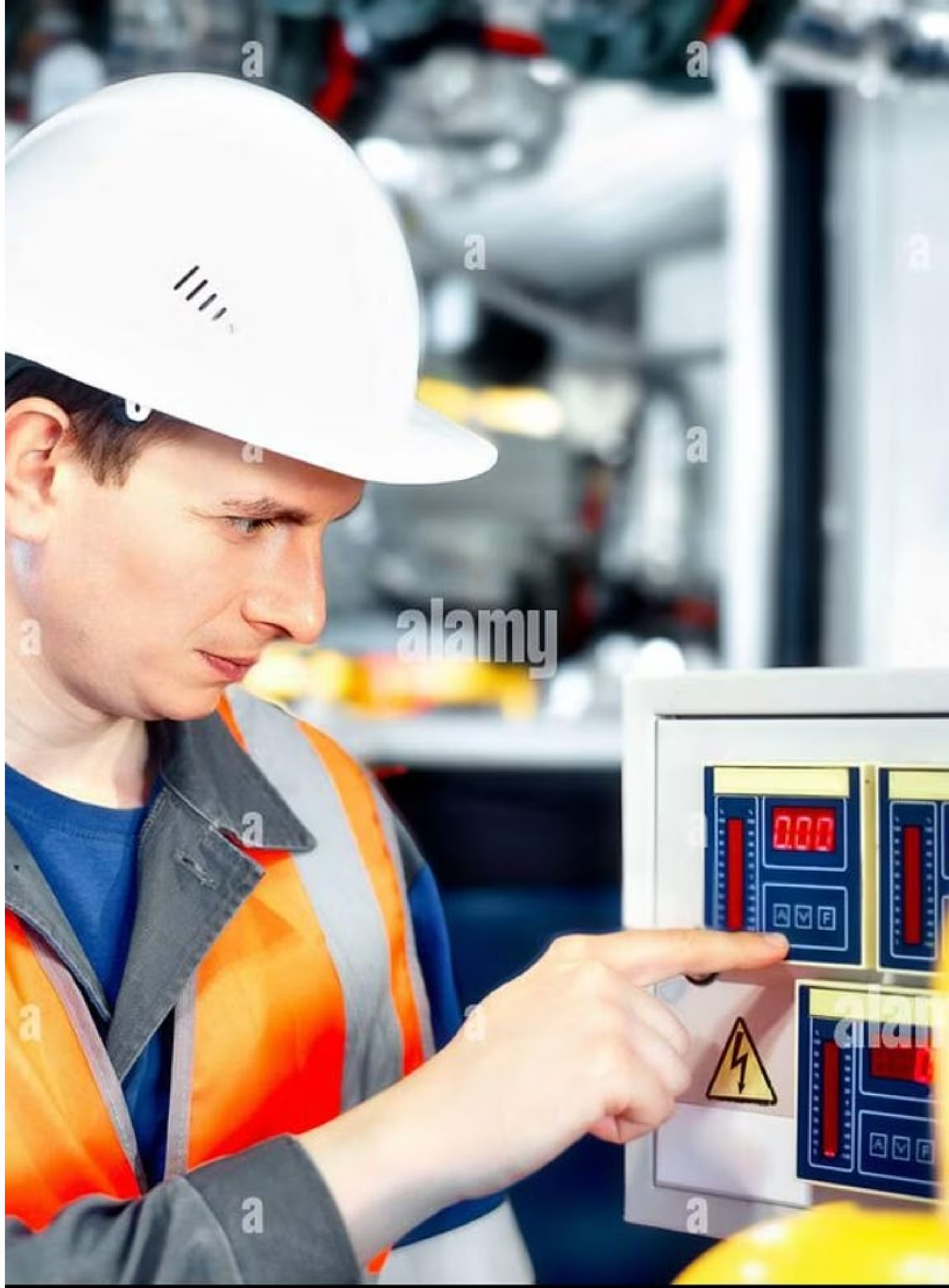
The knowledge of fasteners aligns with several Red Seal tasks, particularly those related to safety, tools, and preparation for installation.

Red Seal Block Alignment

Red Seal Block	Title
1	Safety
2	Fasteners, Tools and Testing Instruments
3	Properties, Characteristics, and Safe Handling of Fuel Gases
4	Utilization Codes, Acts and Regulations
4A	Utilization Codes, Acts, and Regulations Ontario Supplement

Red Seal Block Alignment (Continued)

Red Seal Block	Title
5	Introduction to Electricity
6	Technical Manuals, Specifications, Drawings and Graphs
7	Customer Relations
8	Introduction to Piping and Tubing Systems
9	Introduction to Gas Appliances



Red Seal Task Alignment

1 Task 1

Performs safety-related functions.

2 Task 2

Maintains and uses tools and equipment.

3 Task 3

Plans and prepares for installation, service and maintenance.

4 Task 4

Fits tube and tubing for gas piping systems.

Red Seal Task Alignment (Continued)

1 Task 5

Fits plastic pipe for gas piping systems.

2 Task 6

Fits steel pipe for gas piping systems.

3 Task 7

Installs venting.

4 Task 8

Installs air supply system.

Red Seal Task Alignment (Continued)

1 Task 9

Installs draft control systems.

2 Task 10

Selects and installs electronic components.

3 Task 11

Selects and installs electrical components.

4 Task 12

Installs automation and instrumentation control systems.

Red Seal Task Alignment (Continued)

1. **Task 13**

   Installs gas-fired system piping and equipment.

2. **Task 14**

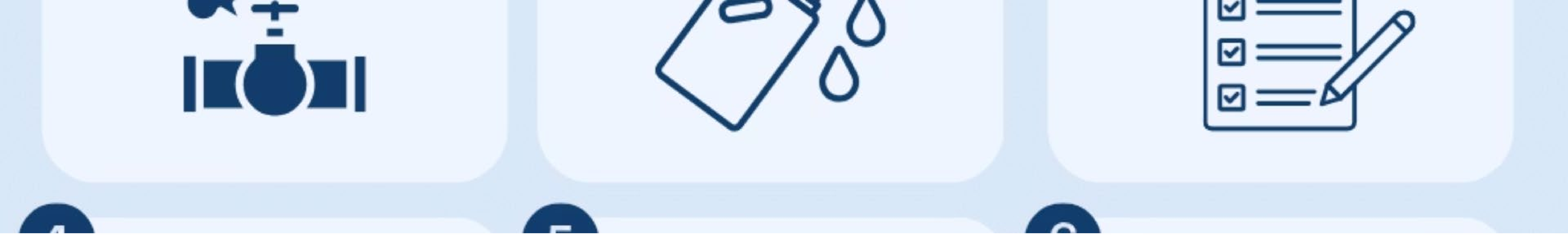
   Installs gas-fired system components.

3. **Task 15**

   Installs propane storage and handling systems.

4. **Task 16**

   Tests gas-fired systems.



Red Seal Task Alignment (Continued)

1. **Task 17**
   Commissions gas-fired systems.
2. **Task 18**
   Maintains gas-fired systems.
3. **Task 19**
   Repairs gas-fired systems.
4. **Task 20**
   Decommissions gas-fired systems.

Selecting the Right Fastener: Decision Process

Identify Requirements

Determine material, weight, and environmental factors

Research Options

Explore available fastener types for the application

Verify Compatibility

Ensure fastener is appropriate for the materials

Proper Installation

Use correct tools and techniques

Best Practices for Fastener Use

Storage

Store fasteners in a clean, dry environment to prevent corrosion and damage.

Selection

Always choose fasteners designed specifically for the application and materials involved.

Installation

Use proper tools and techniques to avoid damaging the fastener or the materials being joined.

Inspection

Regularly check fasteners for signs of wear, corrosion, or loosening, especially in applications with vibration.

Summary: Key Takeaways

Proper Selection

Choose fasteners based on material, weight, and environmental factors

Diverse Options

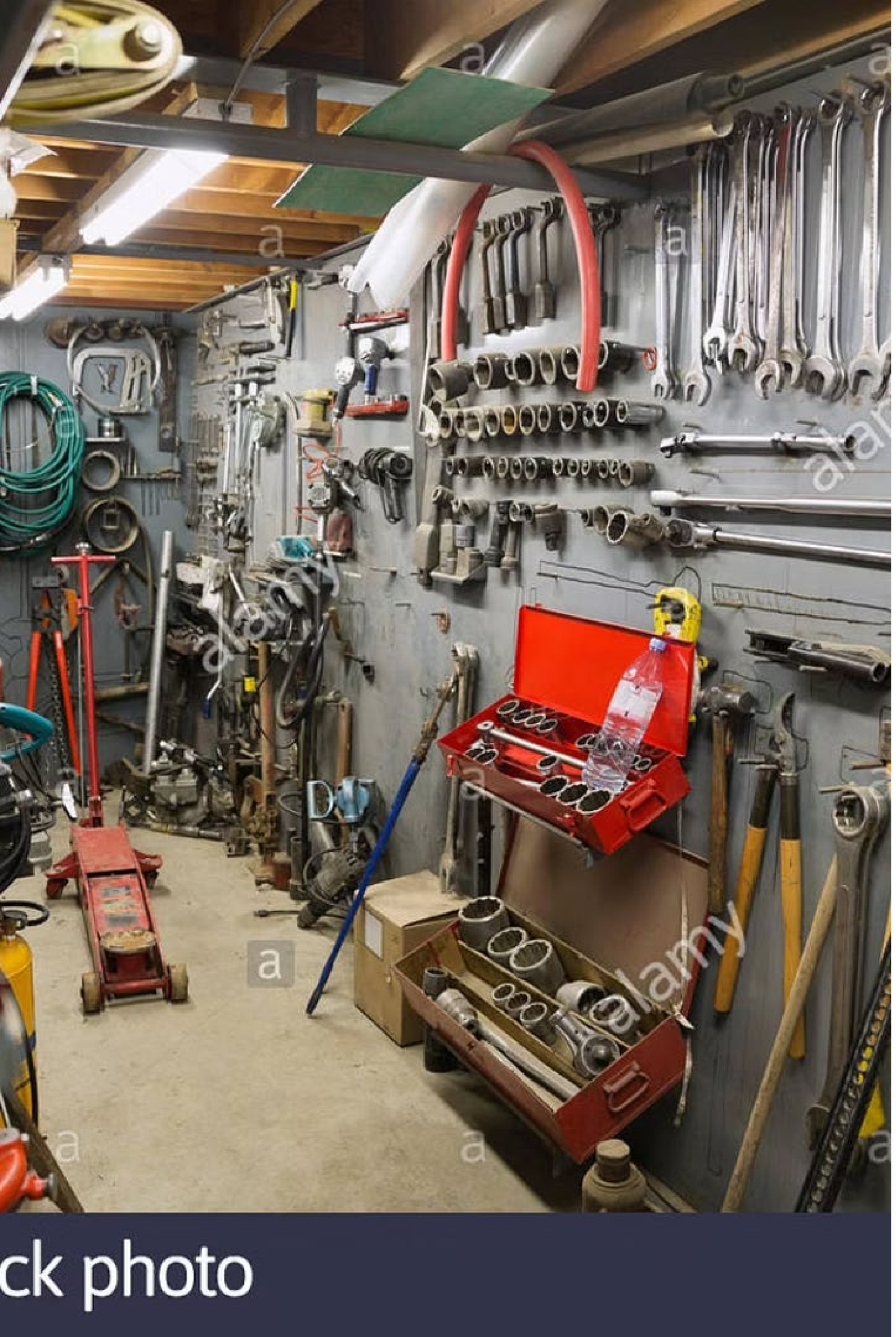
Understand the wide variety of fasteners available for different applications

Safety First

Ensure all installations are secure and meet safety standards

Continuous Learning

Stay updated on new fastener technologies and best practices



CSA Unit 2

Chapter 2
Hand Tools for Gas Technicians

This presentation covers the essential hand tools used by gas technicians and fitters. Understanding how to select, maintain, and safely use the correct tools will save time, money, and energy while ensuring efficient and safe work practices.

Purpose and Objectives

Purpose

To enable the gas technician/fitter to choose the correct tool for the correct job. This will save time, money, and energy.

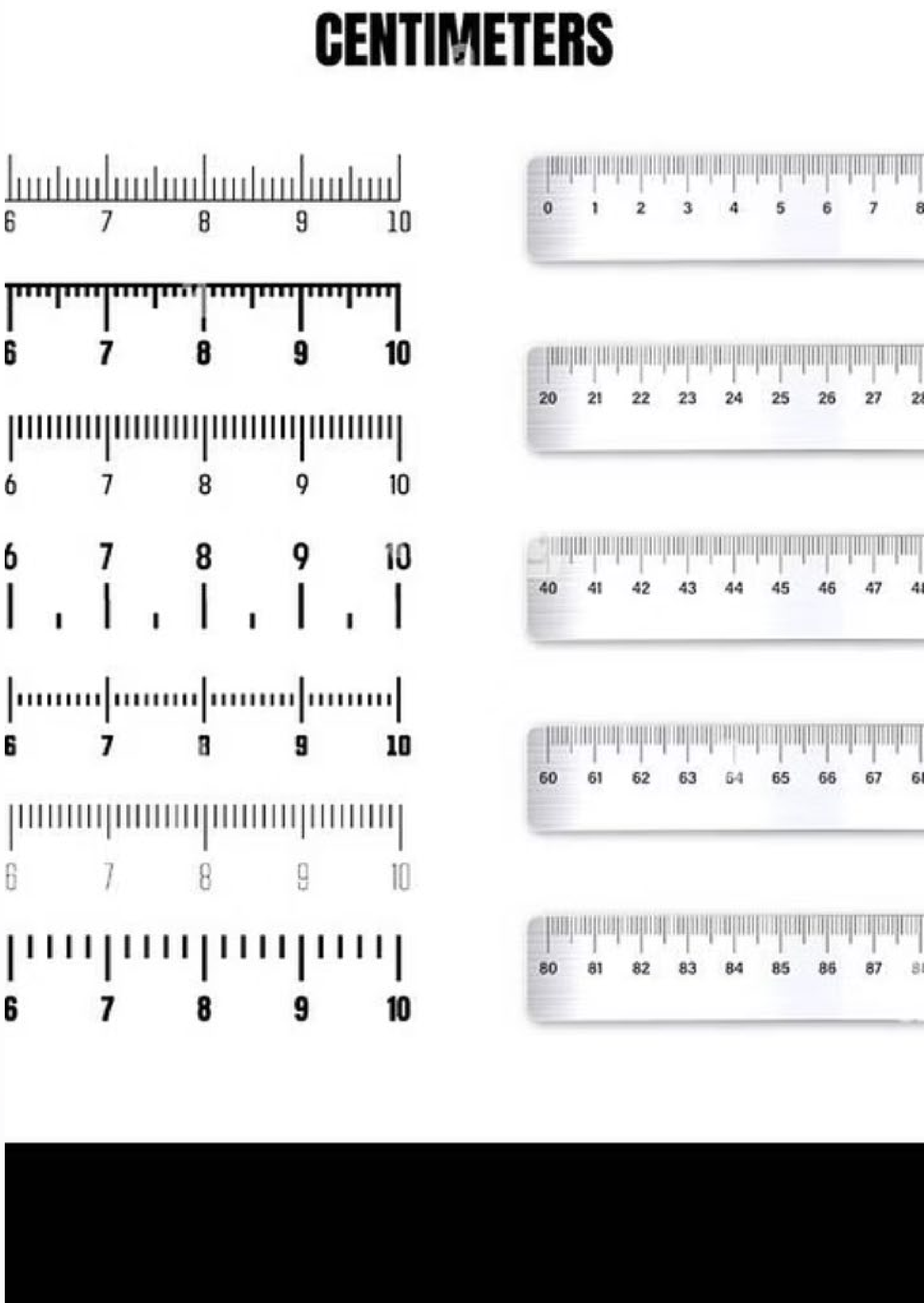
Objectives

At the end of this presentation you will be able to:

- indicate the correct tools for the task
- demonstrate how to use hand tools safely and efficiently
- identify tools the piping industry uses

Terminology

Term	Abbreviation	Definition (symbol)
Millimetre	mm	Unit of length.



Requirements for Using Hand Tools

It is very important for a gas technician/fitter to be able to identify and select the proper tool for the job at hand. It is also important to maintain and store tools properly and use them in a safe, effective way.

This section describes some of the general requirements for selecting, storing, maintaining, and using these tools.

Tool Selection

Choosing the right tool for each specific task

Tool Storage

Proper storage to protect and organize tools

Tool Maintenance

Regular care to ensure longevity and effectiveness

Tool Safety

Safe handling practices to prevent injuries

Selecting Tools

When selecting the correct tool for a job, you must consider the following:

Design Features

Find the right tool for the job!

Work Environment

Consider the work space available

Type of Work

The specific task that you must do

Materials

The materials that you must work on

Part Sizes

The size(s) of the part(s) you're working with

Fastener Types

The types of fasteners you used

Force Limits

Limits on the force that you may apply

Safety

Always prioritize safety in tool selection

Efficiency

Consider speed and efficiency of the work

Consequences of Using Inappropriate Tools

Damage to Workpiece

Using the wrong tool can damage the materials you're working on

Tool Damage

Improper use can ruin expensive tools

Time Loss

Inappropriate tools slow down your work

Safety Hazards

Wrong tools can create dangerous situations

Maintaining Tools

Good maintenance improves tool function and ensures their long working life. Good maintenance is mostly common sense, as follows:

Keep tools dry

Keep tools that can rust dry

Protect sharp edges

Protect the sharp edges of cutters, saw, and chisels when you lay them down

Handle with care

Handle fragile tools with care

Oil after exposure

Dry moisture-exposed tools and lightly oil them before putting them away

Lubricate moving parts

When tools have moving parts, lubricate them at points of wear

Tighten handles

Tighten wooden handles on tools at the first sign of looseness

Storing Tools

Leaving tools lying about or jostling against others can pose risk of damage for the tools. Stealing or misuse of expensive tools is also possible if you do not keep them in a secure place.

Protect Small Tools

Encase small or easily damaged tools

Protect Cutting Edges

Protect cutting edges and filing surfaces

Accommodate Size

Accommodate the size and weight of the tool

Prevent Damage

Prevent jostling or dropping of the tool

Weather Protection

Protect tools from the weather, dampness, and corrosive materials

Security

Keep tools secure against theft

Safety

Prevent people who are unqualified to use the tools from getting injured

Cleanliness

Keep tools clean

Using Tools Safely

Careless handling or incorrect use of many of the tools that gas technicians/fitters use can be dangerous.

Use Safety Equipment

Use the prescribed safety clothing and equipment

Check Tool Appropriateness

Check that you have the right tool for the job. Check the tool's function and size and the materials you are working on

Inspect Tool Condition

Check that the tool is in good order. All parts must be secure and cutting edges sharp

Check Work Area

Check the area for objects that might impede your or the tool's movement as you work

Secure Work Piece

Check that the work piece is held firmly in the proper position

Position Yourself Correctly

Stand or sit in the correct position for using the tool

Types of Hand Tools

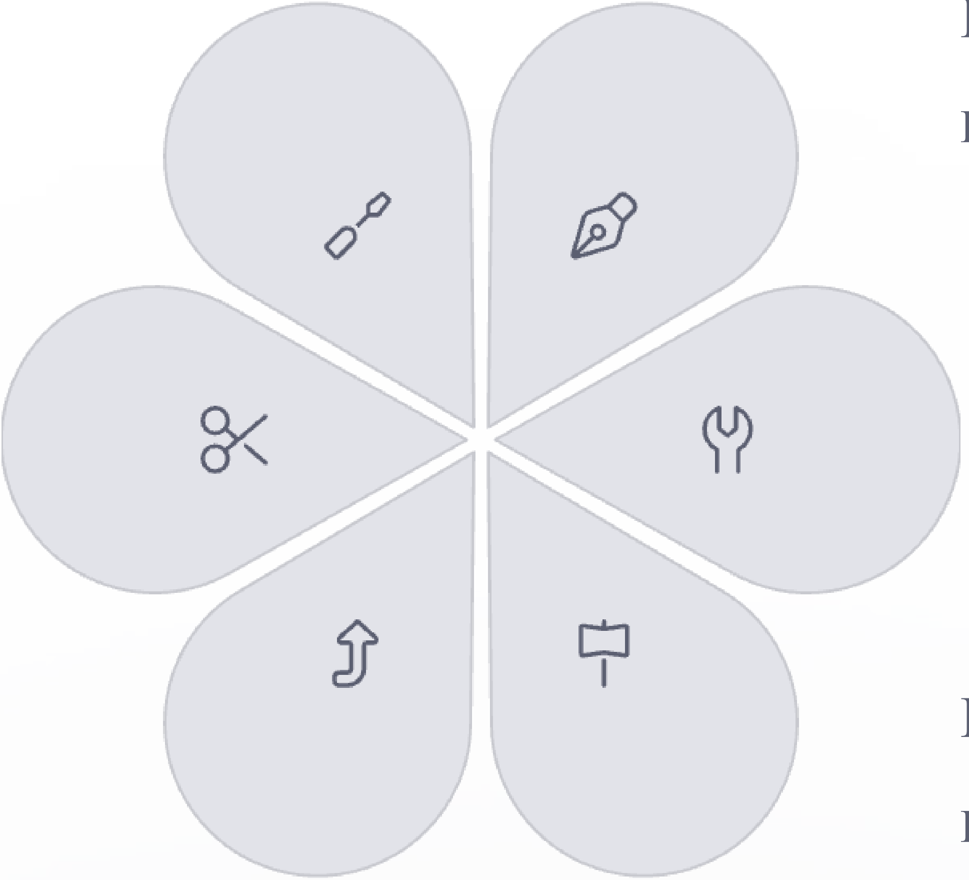
The use and understanding of hand tools is a must for the gas technician/ fitter. There are tools for nearly every situation you can come across in the industry. It is important to be able to identify the tool you need.

Screwdrivers

Various types for different screw heads

Pliers

For gripping and manipulating objects



Cutting Tools

Snips, pipe cutters, and other cutting implements

Wrenches

For turning nuts, bolts, and pipes

Measuring Tools

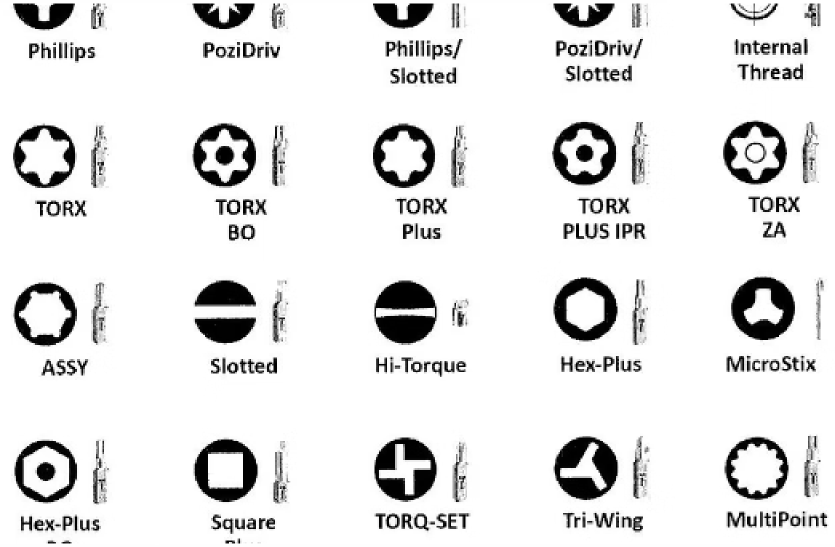
Levels, plumb bobs, and other measuring devices

Hammers

For striking and shaping

Screwdrivers and Allen Keys

Screwdrivers are available in many designs, sizes, and lengths. The most commonly used ones are the regular (straight blade), Phillips, and Robertson screwdrivers, and Allen keys.



Screwdriver Tips

Different tips for various screw head shapes

Common Screwdriver Set

A typical set includes various sizes of straight, Phillips, Robertson, and Allen keys

Practical Application

Using the correct screwdriver ensures efficient work and prevents damage to screws

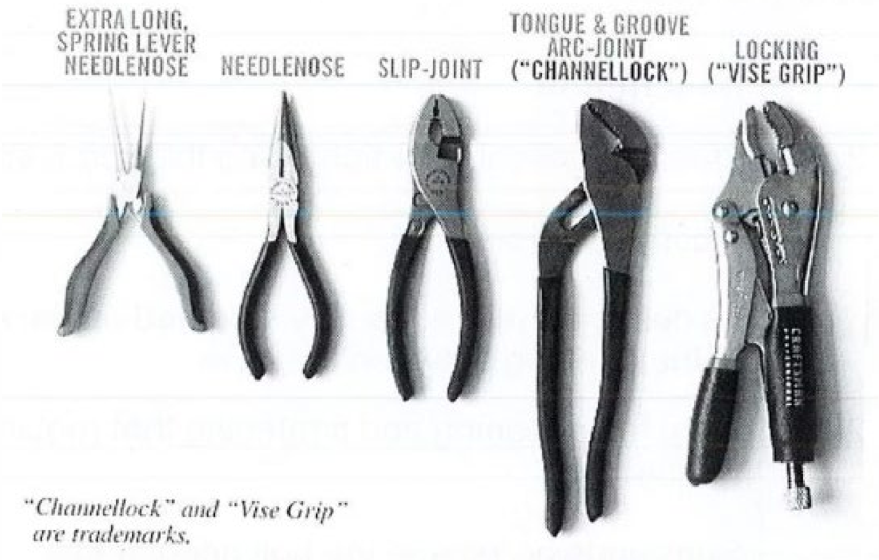
Pliers

Pliers help increase gripping power. The following three pliers are the most commonly used types in the piping trades:

Arc-joint Pliers

Come in various sizes with maximum capacities up to 4 in (100 mm). The tongue and groove design provide maximum power at all openings.

Figure 2-2
Pliers



Water Pump Pliers

Such as Tongue-and-groove pliers have a maximum capacity of 2 in (50 mm). The multiple slip joint setup provides for rapid changes of jaw opening.

Combination Pliers

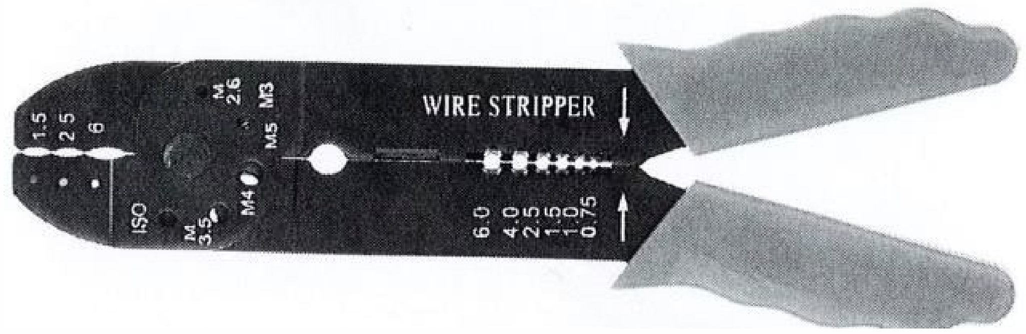
Such as slip-joint pliers are easy to use for a multitude of tasks from opening spring-loaded hose clamps to bending metal. The jaws come with cutters for snipping wires.

Wire Stripper

A wire stripper (or wire stripping pliers) is a tool that facilitates removal of insulation from electrical conductors. It usually has different hole sizes to accommodate removing insulation from wires of different gauges.

- Removes insulation without damaging the conductor
- Features multiple hole sizes for different wire gauges
- Essential for electrical work in gas installations
- Some models include additional features like wire cutters

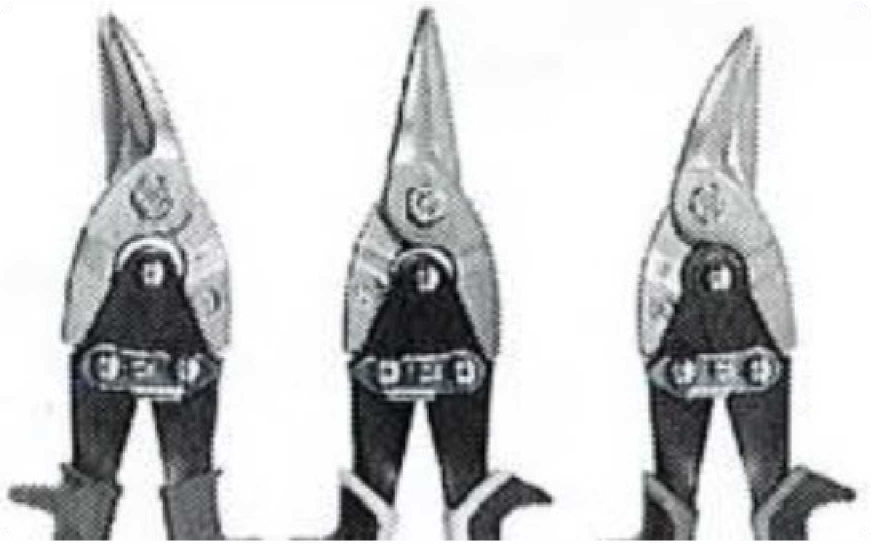
Figure 2-3
Wire stripper



Wire stripper with multiple gauge holes

Snips

Keep at least one pair of snips in your tool box to cut such things as sheet metal duct work, sheet metal piping, and hanger strapping or grappling bar. Never use snips to cut wire (it nicks the blades).



Common Types of Snips

Different snips are designed for specific cutting applications

Practical Application

Using snips to cut sheet metal for ductwork

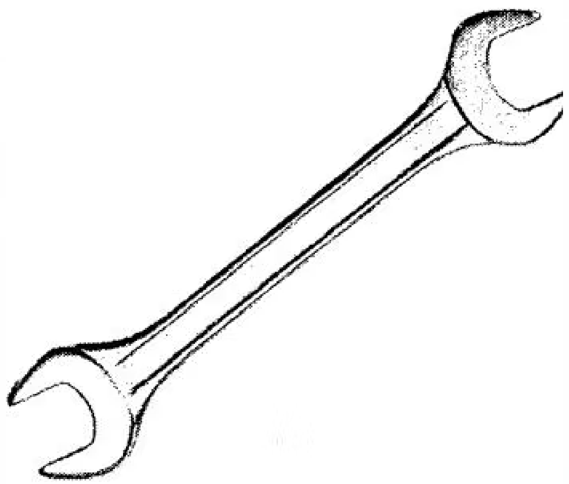
Aviation Snips

Color-coded handles indicate cutting direction: red for left, green for right, yellow for straight

Wrenches: Open-Ended and Box

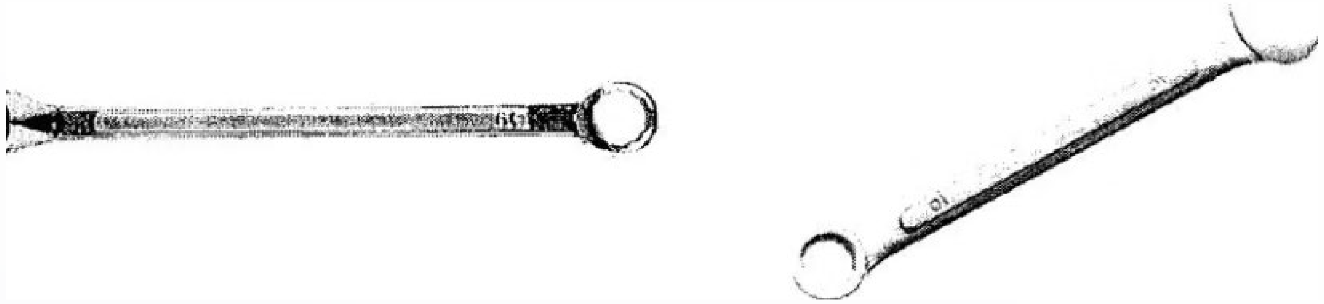
Open-Ended Wrench

Ideal for loosening or tightening that requires very little torque. Mostly double-ended. Its designated size, usually stamped on the side, is the fixed size of the opening between the jaws.



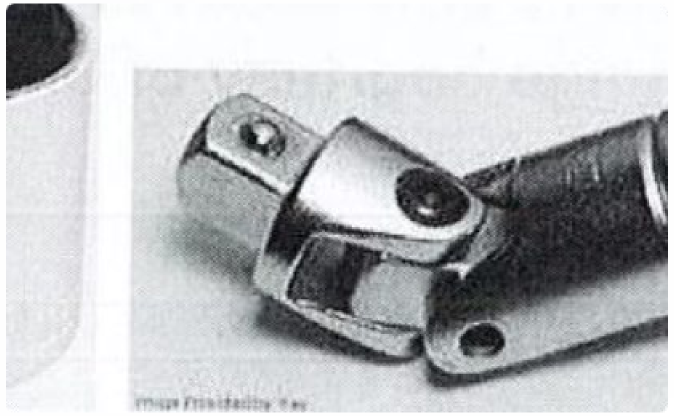
Box Wrench

Ideal for loosening and tightening that require a high amount of torque. Surrounds or "boxes" the bolt head or nut. The box head circular opening usually has 6 or 12 notches (points). It is safer than the open-ended wrench because it is less likely to slip. It is good for working in close quarters because you can take as little as 1/12 turn with this at one stroke.



Socket Drives

The common socket drive is like a box wrench, but is a detachable socket that the gas technician/fitter must use on various handles. A set usually contains various size sockets (1/4 in to 3/4 in) or (10 mm to 19 mm) and a ratchet.

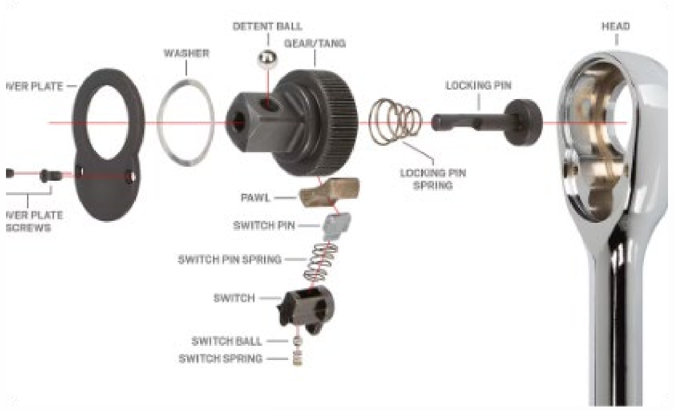


Socket Drive Set

Complete socket set with ratchet handle and various socket sizes

Practical Application

Using socket drives for efficient tightening in confined spaces

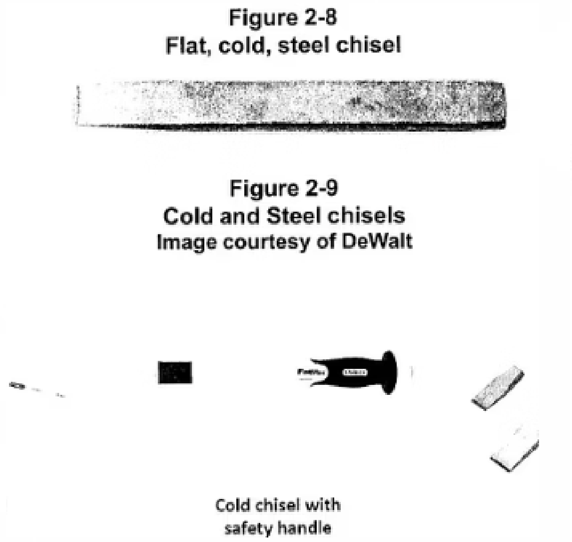


Socket Drive Components

Ratchet handle, extension bars, and interchangeable sockets

Chisels

Chisels work on wood or on steel. For good workmanship, you must keep them ground and sharpened. Ensure that you use eye protection when chipping, to protect your eyes from flying particles.



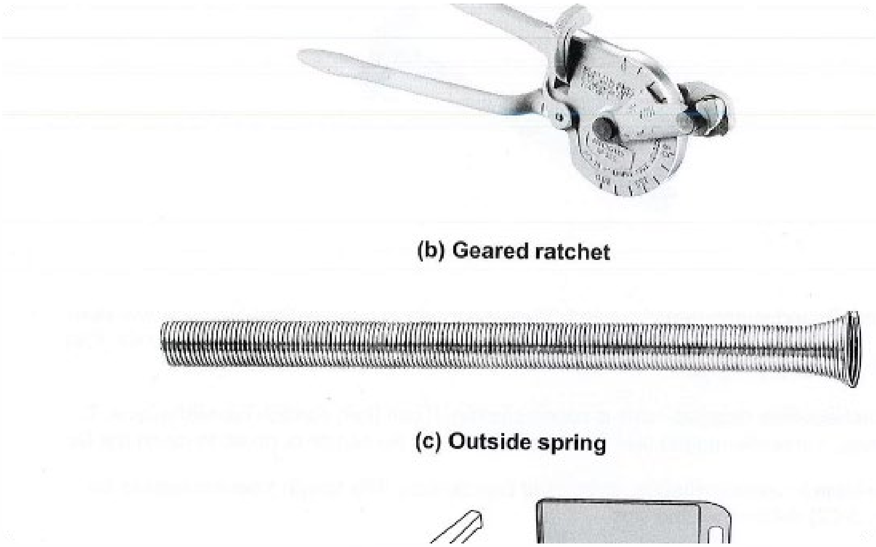
Various types of steel chisels include flat cold chisels, cape chisels, round nose chisels, and diamond point chisels. Each has a specific purpose and cutting edge design.

Steel Chisel Types

Type	Description
Flat, cold chisel	The most common type and has a flat, wide cutting face for cutting or chipping metal or concrete. Some applications are cutting thin plate, shearing off rivet or bolt heads, and removing weld spots. It is very useful when dismantling equipment with corroded or seized components such as brackets. Its cutting edge is ground axially along the chisel. The included angle of the cutting face is 70°.
Cape chisel	Has a relatively small point. It cuts keyways or slots in metal and facilitates dividing work so you can use a cold chisel to finish the job.
Round nose chisel	Has its cutting-edge ground at 60° to the main axis. One edge is ground flat and the other round.
Diamond point chisel	Has a solid point that can help cut V-grooves, draw holes, and holes in flat stock.

Tubing Benders

There are several types of tubing benders, but they operate similarly for bending tubing up to 3/4 in diameter. The three most common types are lever, geared-ratchet, and outside-spring. Tube bending kits that are available have a number of different size heads and a range of tube sizes to meet the needs of gas technicians/fitters.



Lever Tubing Bender

Uses leverage to create smooth bends in tubing

Tube-Bending Kit

Complete kit with multiple heads for different tube sizes

Practical Application

Creating precise bends in gas line tubing

Hammers

Head weight (weight without the handle) characterizes hammers. The gas technicians/fitters kit includes two basic types of hammers:

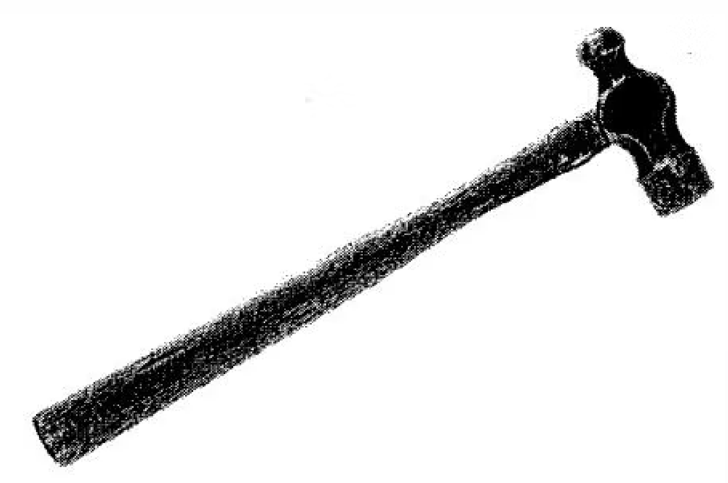
Ball-Peen Hammer

May have weight of 0.11, 0.17, 0.23, 0.34, 0.5, 0.75, or 1 kg. The round-shaped part of the head helps shape metal. The face is slightly domed so that it does not leave marks on struck metal. You can also use it to strike punches.

Figure 2-11
Ball-peen hammer

Claw Hammer

Its main uses are drawing, pulling, and driving nails. It has a steel head with a wood or steel handle.



Files

Files help smooth and shape parts by hand. They are made of heat-treated, high-carbon steel. This steel is hard and ensures an effective cutting surface, but it is brittle. Because of this, files may break if used to pry objects.

File Maintenance

In use, the file becomes clogged--this is called pinning. It can then scratch the workpiece. To prevent pinning, rub chalk into the teeth before filing. Use a file scorer or brush to clean the file.

Common Shapes

Some common cross-sectional shapes are: flat (mill), square, triangular (three-square), half-round, and round (rat tail).

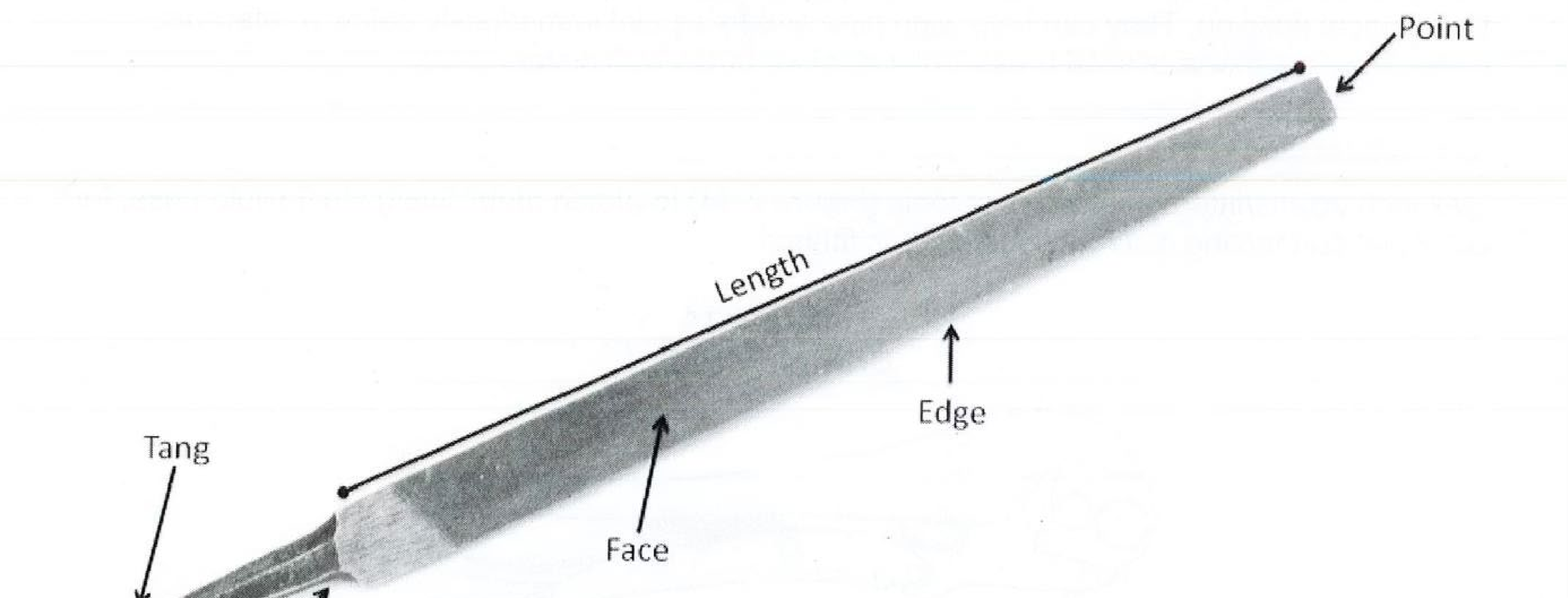
File Varieties

Files are available in various shapes, sizes, and coarseness. The length from the heel to the point determines the size.

Storage

To protect the filing surfaces, store files in a cardboard sleeve.

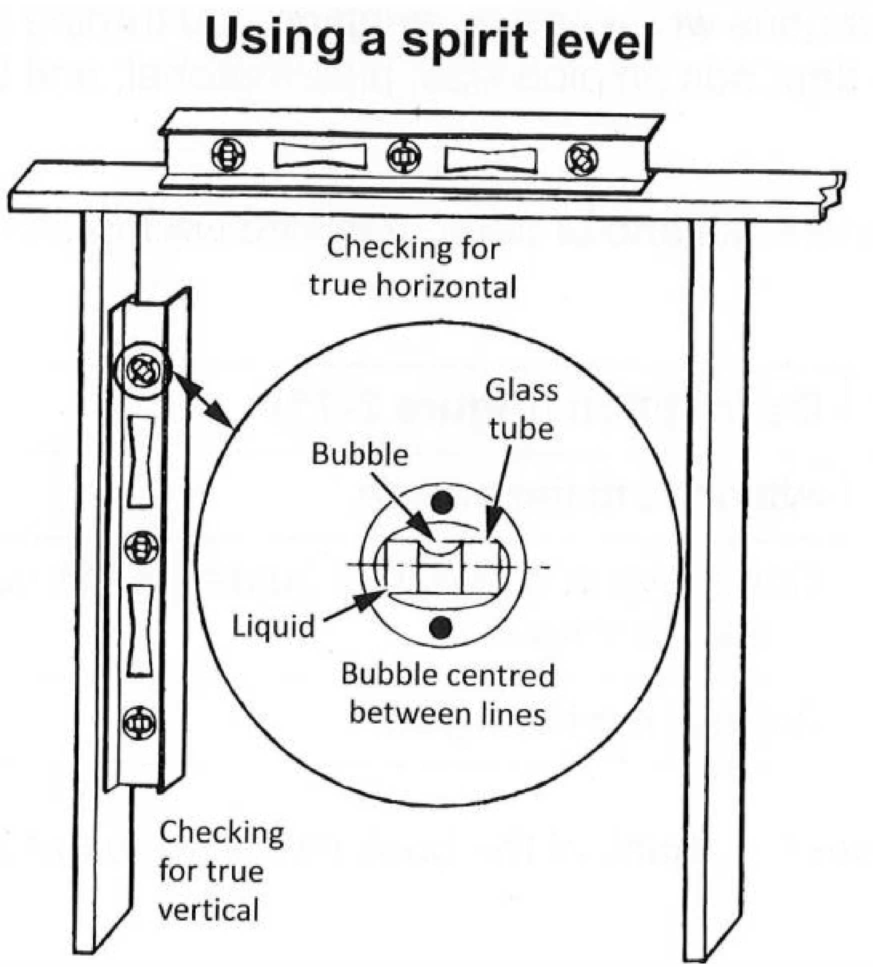
Figure 2-12
Parts of a file



Spirit Levels

Spirit levels help ensure that objects are plumb, level, or have the proper grade. Their sizes range from a few inches to several feet in length. Most are made of aluminum or cast aluminum.

- Used to check horizontal (level) alignment
- Used to check vertical (plumb) alignment
- Some models include angle measurement capabilities
- Essential for ensuring proper pipe installation
- Available in various lengths for different applications



A typical spirit level with horizontal and vertical vials

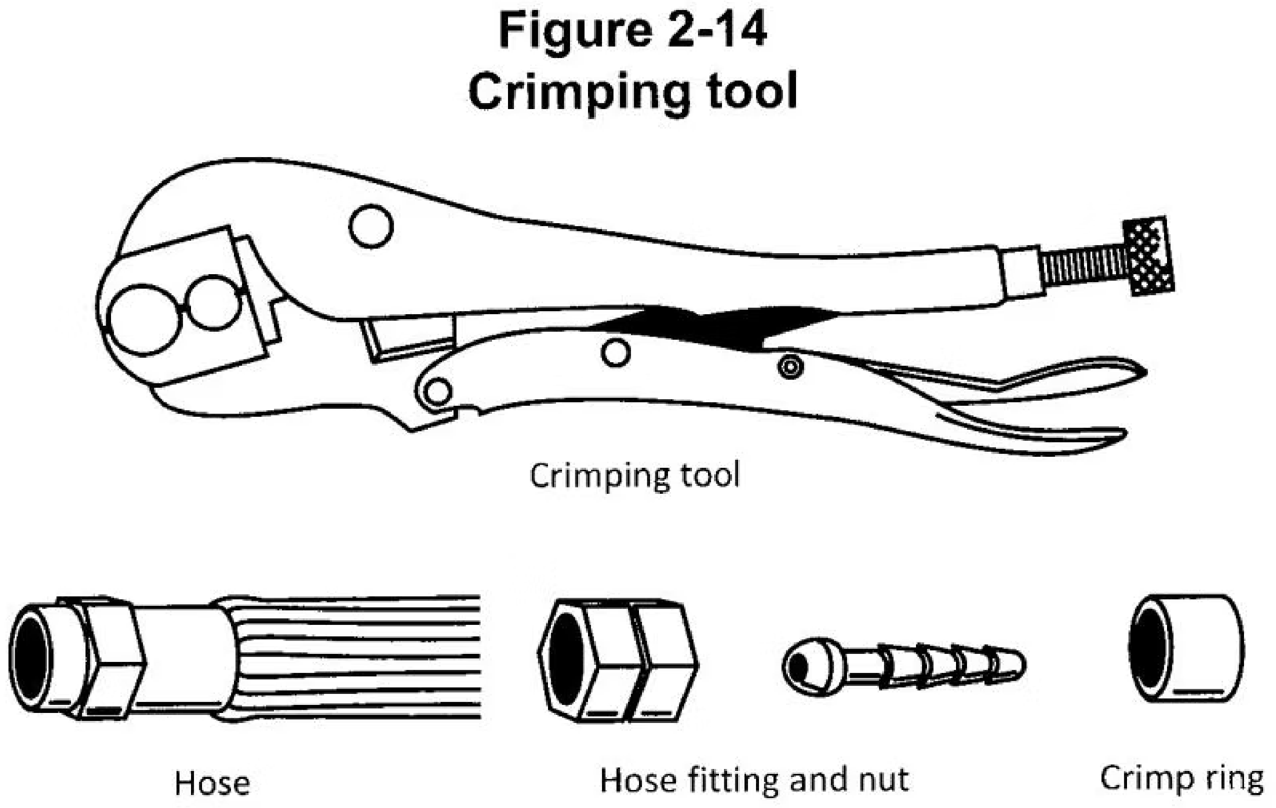
Plumb Bobs and Crimping Tools

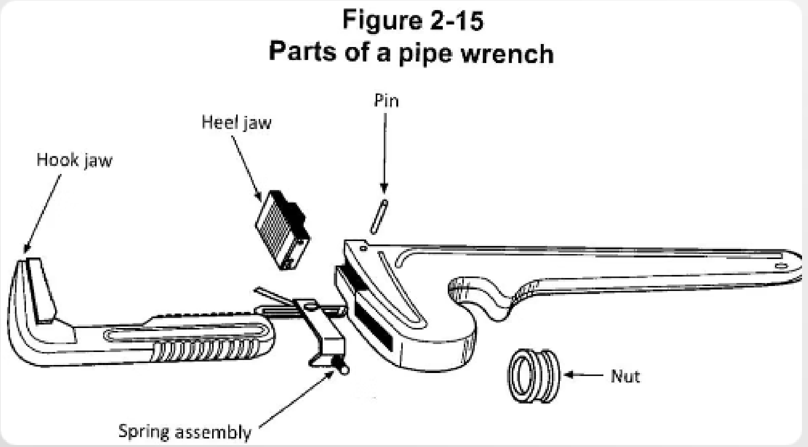
Plumb Bobs

Plumb bobs are heavy, balanced, pointed weights suspended from a strong cord to determine a true vertical position. They can help align pipe and fix a point immediately below a reference point. They are made of solid brass, solid steel, or brass with a steel point.

Crimping Tools

Gas technicians/fitters use crimping tools to attach metal fittings to flexible hose, for example, connecting oxyacetylene hose to fittings.





Pipe Wrenches

Gas technicians/fitters use various wrenches for gripping and turning pipe and fittings. The type of wrench selected for a job depends on pipe size, pipe material, and the amount of working space available.

The jaws of the straight pipe wrench and of other standard wrenches have teeth for gripping round objects.

Heel Jaw

Attached to the handle

Hook Jaw

Can move in and out by adjusting the nut on the threaded section of the hook jaw

Nut

Adjusts the hook jaw

Housing

The wrench housing holds both the shank of the hook jaw and the nut in position

Straight Pipe Wrench

Description

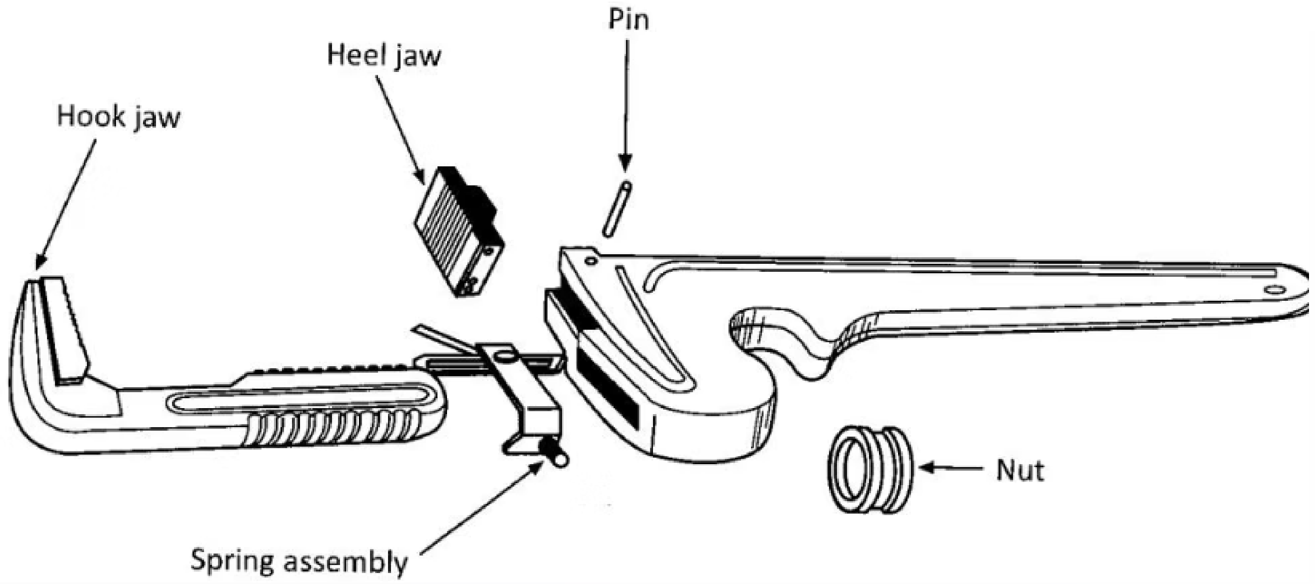
Available in ten models, each designed for a certain range of pipe sizes. The length of pipe wrenches designate their sizes. Like the other standard wrenches, this wrench comes with either an aluminum or cast-iron handle.

- Most common type of pipe wrench
- Used for gripping and turning pipes
- Adjustable jaw width for different pipe sizes
- Available with aluminum or cast-iron handles

Size and Pipe Capacity

Available in ten models. The smallest is 6 in (150 mm) long and has a pipe capacity of NPS 3/4. The largest is 60 in (1500 mm) long for use on larger sizes to NPS 8 pipe.

Figure 2-15
Parts of a pipe wrench



End Pipe Wrench

Description

Has an angled opening. You use this when working in tight quarters or next to a wall or a corner.

- Specialized design for confined spaces
- Angled jaw opening for better access
- Ideal for working near walls or corners
- Functions similarly to straight pipe wrench

Size and Pipe Capacity

Made in eight sizes. Pipe capacity ranging from NPS 3/4 to NPS 5 in.

Heavy-Duty Offset Pipe Wrench

Description

Has a jaw opening parallel to the handle and a narrower hook jaw head. These features allow easy entry to tight spots. Several models are available in the market.

- Designed for accessing confined spaces
- Parallel jaw opening to the handle
- Narrower hook jaw head for better access
- Heavy-duty construction for demanding applications

Size and Pipe Capacity

Pipe capacities of NPS 2, NPS 2-1/2, and NPS 3.

Vertical Pipe Wrench

Description

You can use this on either vertical or horizontal pipe in closely confined areas. It is especially useful for underground valve locations.

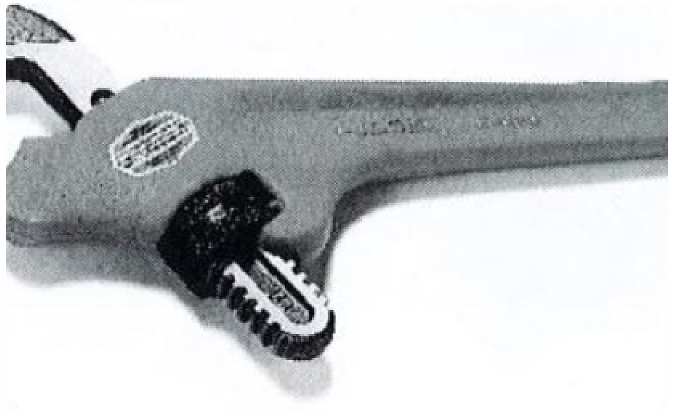
- Specialized design for vertical applications
- Can be used on horizontal pipes as well
- Ideal for underground valve access
- Provides leverage in confined spaces

Size and Pipe Capacity

Pipe capacity is NPS 2.

Hexagonal Wrench

The hexagonal wrench may have either of these two designs: straight or offset. Both types give a multi-sided grip, but the main difference between the two is the extra-wide opening of the offset.



Hexagonal Wrench

Provides multi-sided grip on pipe fittings

Straight Design

Standard configuration for normal access situations

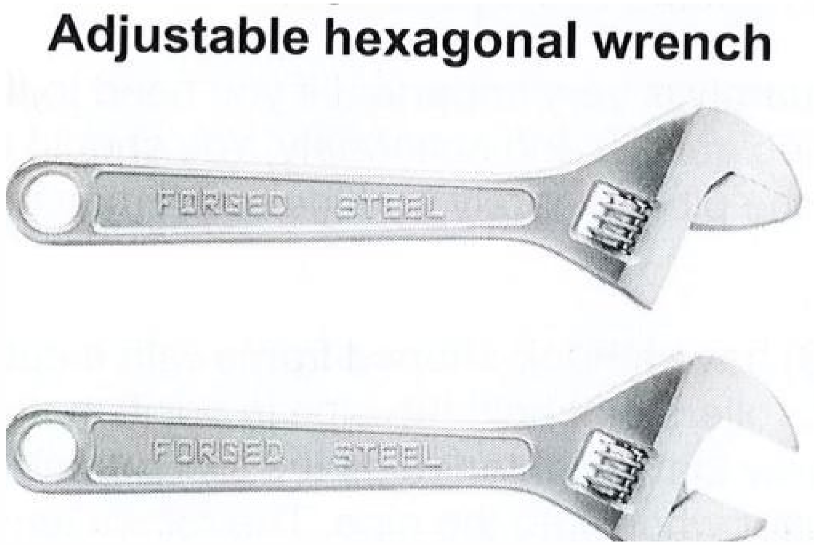
Offset Design

Features extra-wide opening for better access in tight spaces

Adjustable Wrenches

Adjustable wrenches have a thin adjustable head for working in close quarters and are useful for tightening or loosening nuts and bolts on flanged fittings and valves. There are over a dozen models and jaw openings ranging from 1/2 in to 2-1/2 in (12 mm to 63 mm).

- Versatile tool for various fastener sizes
- Thin profile for accessing tight spaces
- Ideal for flanged fittings and valves
- Available in multiple sizes for different applications
- Adjustable jaw accommodates different fastener sizes

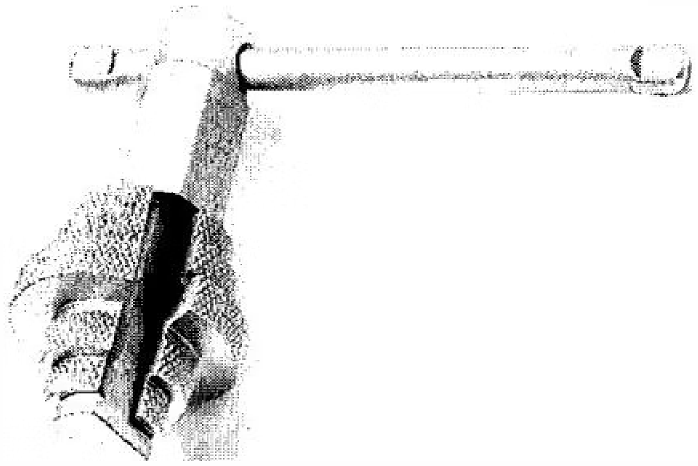


Adjustable wrench with movable jaw

Internal Wrench

The internal wrench holds pipes, nipples, and fixture connections in place from the inside while a gas technician/fitter tightens down a nut. The knurled head is reversible to handle sizes from 1 in to 2 in.

- Specialized tool for internal gripping
- Holds pipes and fittings from the inside
- Allows for tightening connections without external damage
- Reversible knurled head for different pipe sizes
- Essential for certain plumbing and gas fitting applications



Internal wrench with reversible knurled head

Cutting Tools: Pipe Cutters

Pipe cutting is done either by hand or with power tools. Cutters are available in a number of designs and sizes. Their use depends on the size and material of the pipe you cut and the situation under which you carry out the cutting operation.

Square Cuts

Cutting the end of the pipe squarely is very important if you need to thread the pipe

Proper Selection

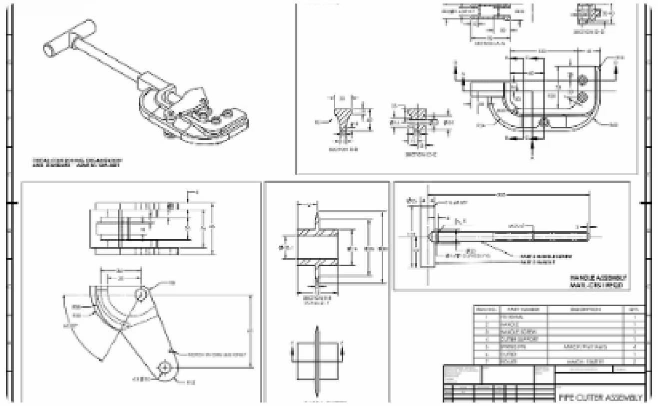
The correctly selected cutter does the best job quickly and accurately

Avoid Hacksaws

You should never use a hacksaw to cut pipe, because it could not cut the pipe squarely and the result may be badly cut threads and broken dies

Pipe Cutter Design

Most pipe cutters have a hook-shaped frame with a cutter wheel at the end. A sliding housing containing two rollers that hold the pipe in position against the wheel is mounted on the stem of the hook. A screw that is tightened as the tool rotates around the pipe moves the sliding housing, forcing the cutter wheel into the pipe. The rollers tend to roll down the external burr raised on the pipe as the cutter wheel moves the metal.



Pipe Cutter Components

Hook-shaped frame, cutter wheel, rollers, and adjustment screw

Cutting Process

The cutter wheel gradually cuts into the pipe as the tool rotates

Clean Result

Properly cut pipe with square end ready for threading

Tool Safety Checklist

Wear proper PPE

Safety glasses, gloves, and appropriate clothing

Inspect tools

Check for damage before each use

Verify correct tool

Ensure you have the right tool for the job

Know proper technique

Understand how to use the tool correctly

Tool Maintenance Schedule

Daily

Clean tools after use, visual inspection

Weekly

Lubricate moving parts, check for wear

Monthly

Thorough inspection, sharpen cutting edges

Quarterly

Complete overhaul, replace worn parts

Tool Selection Process

Identify Task

Determine the specific job requirements

Select Tool

Choose the appropriate tool for the task

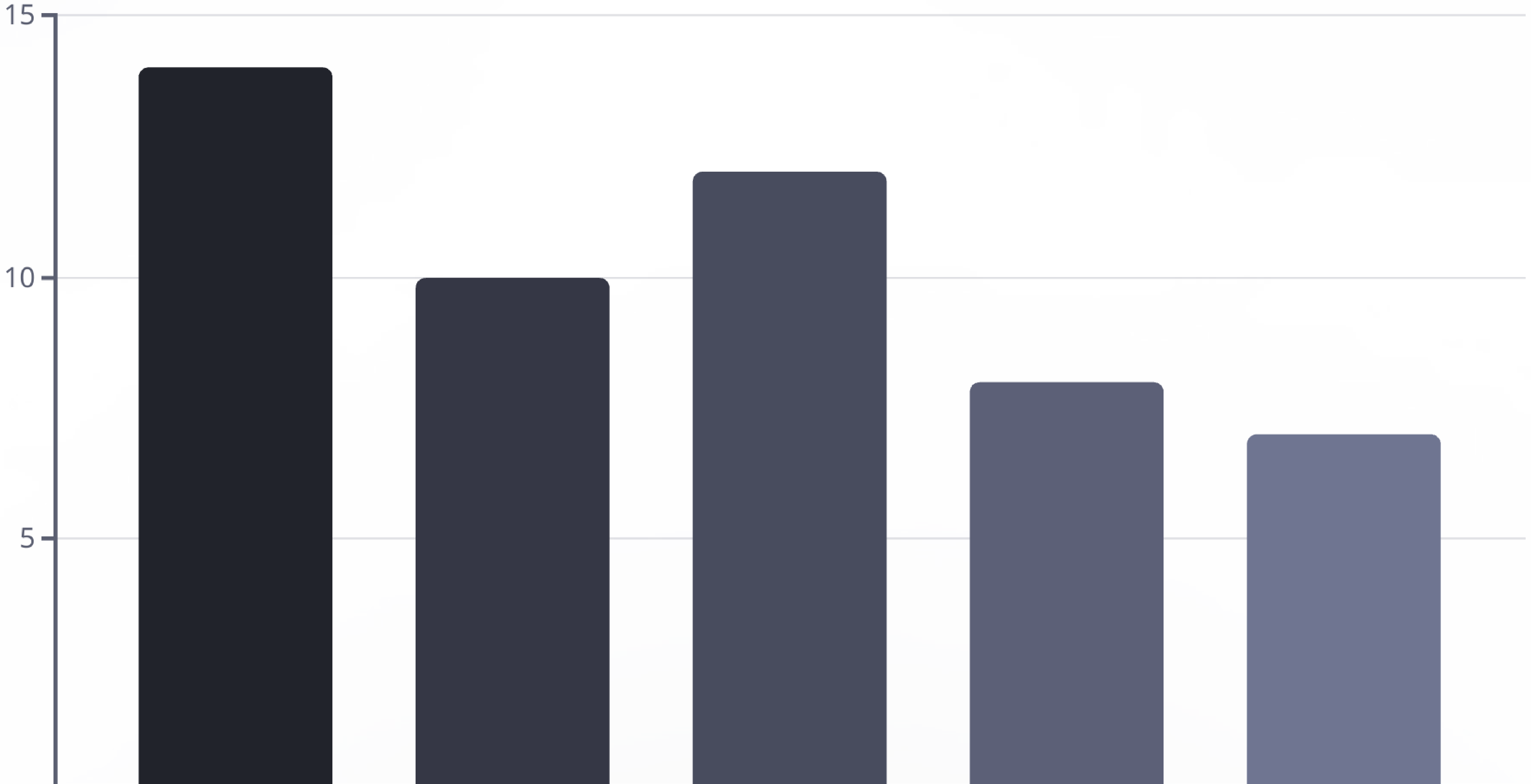
Verify Condition

Ensure the tool is in good working order

Use Properly

Apply the tool correctly and safely

Common Tool Sizes



Tool Storage Solutions

Tool Chest

Multi-drawer storage for organizing various tools by type and size. Provides security and protection from environmental factors.

Tool Bag

Portable solution for carrying essential tools to job sites. Features multiple pockets and compartments for organization.

Wall Storage

Efficient use of workspace with tools visible and accessible. Keeps tools off surfaces and protects them from damage.

Tool Safety Statistics

30%

Injury Reduction

Proper tool maintenance reduces workplace injuries

45%

Efficiency Gain

Using the right tool increases work efficiency

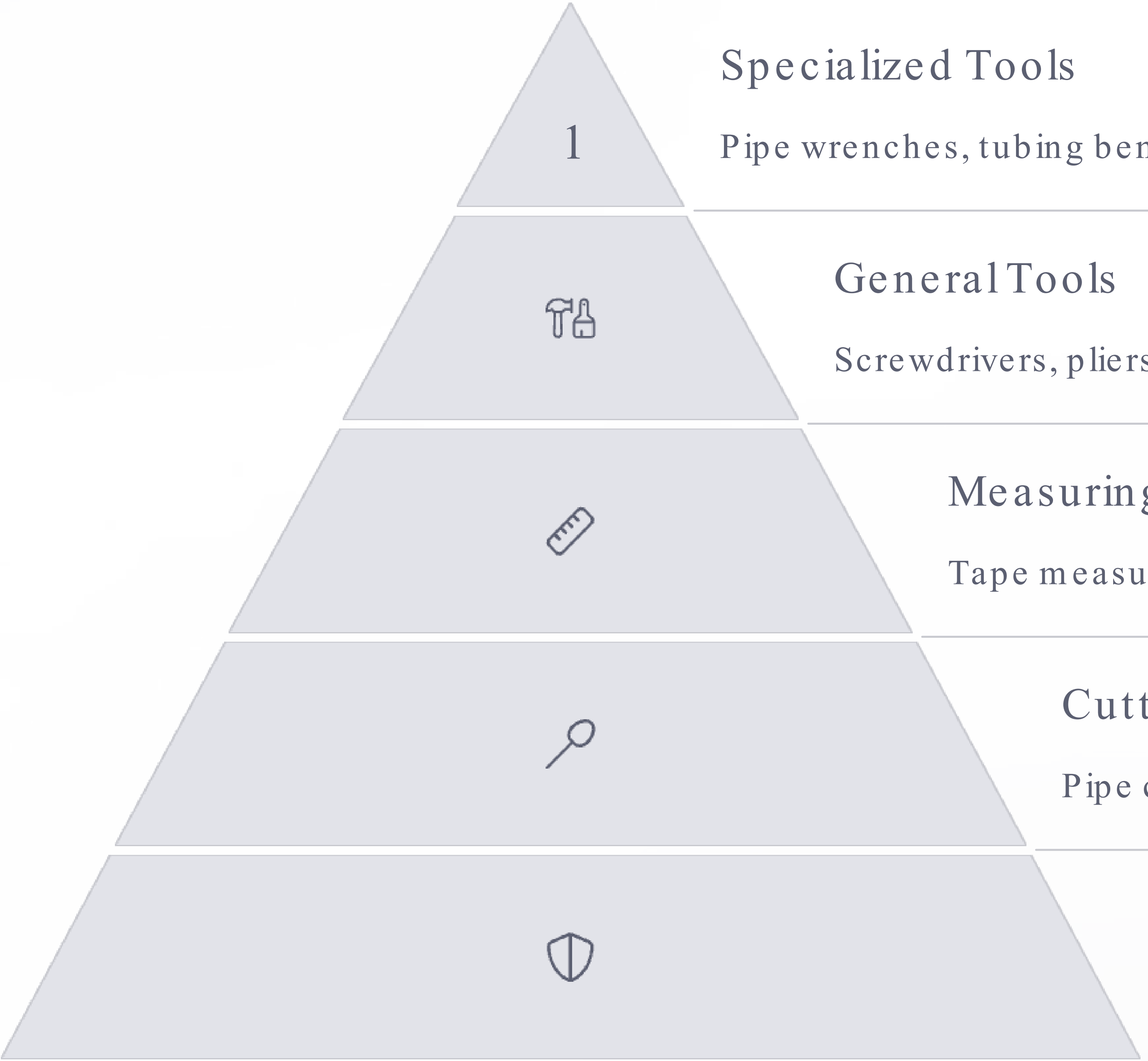
25%

Cost Savings

Well-maintained tools last longer, reducing replacement costs

These statistics highlight the importance of proper tool selection, maintenance, and usage. Not only does it improve safety by reducing workplace injuries by 30%, but it also increases efficiency by 45% and reduces costs by 25% through extended tool life.

Essential Tool Kit for Gas Technicians



Specialized Tools

Pipe wrenches, tubing benders, crimping tools

General Tools

Screwdrivers, pliers, hammers, levels

Measuring Tools

Tape measure, spirit level, plumb bob

Cutting Tools

Pipe cutters, snips, files

Safety Equipment

Gloves, safety glasses, ear protection

Tool Handling Best Practices

Proper Grip

Hold tools firmly with the appropriate grip to maintain control and prevent slipping.

Body Positioning

Maintain stable footing and proper body alignment to prevent strain and injury.

Force Application

Apply force gradually and in the correct direction for the tool being used.

Tool Inspection

Always inspect tools before use to ensure they are in good working condition.

Proper Storage

Return tools to their proper storage location after use to prevent damage and loss.

Clean After Use

Remove dirt, grease, and debris from tools after each use to maintain functionality.

Tool Lifespan Factors

Quality

Higher quality tools generally last longer

Usage

Frequency and intensity of use affects lifespan

Maintenance

Regular cleaning and lubrication extends life

Storage

Proper storage prevents damage and corrosion

Tool Selection Decision Tree

Identify the Task

Determine exactly what needs to be accomplished

Consider Material

What type of material will you be working with?

Evaluate Space

How much working space is available?

Assess Force Requirements

How much force will need to be applied?

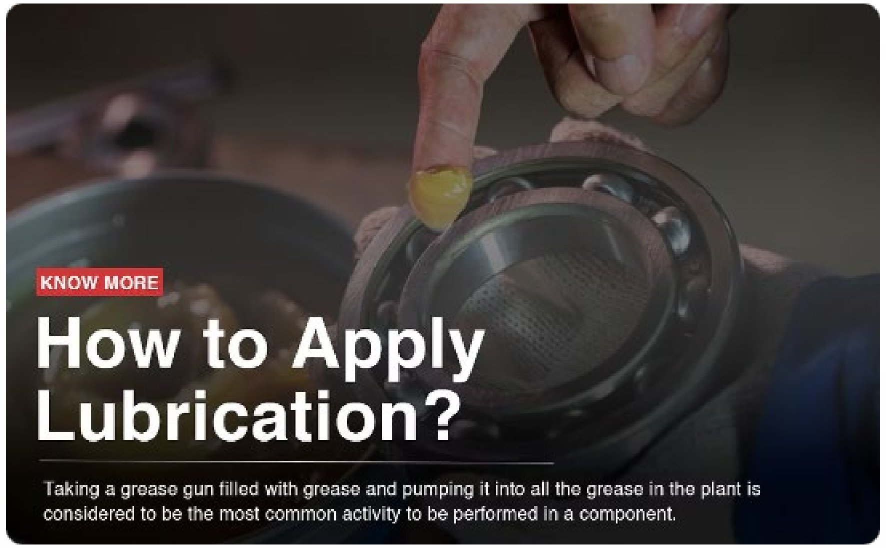
Select Appropriate Tool

Choose the tool that best meets all requirements

Tool Care and Cleaning

Removing Debris

Use a wire brush to remove dirt, rust, and debris from tool surfaces. Pay special attention to moving parts and joints where buildup can affect performance.



Lubrication

Apply appropriate lubricants to moving parts and joints. Different tools may require different types of lubricants - consult manufacturer recommendations.

Sharpening

Maintain sharp edges on cutting tools using appropriate sharpening methods. Dull tools require more force and can be dangerous to use.

Summary: Hand Tools for Gas Technicians

Tool Selection

Choose the right tool for each specific job based on design features, work space, materials, and safety considerations

Tool Variety

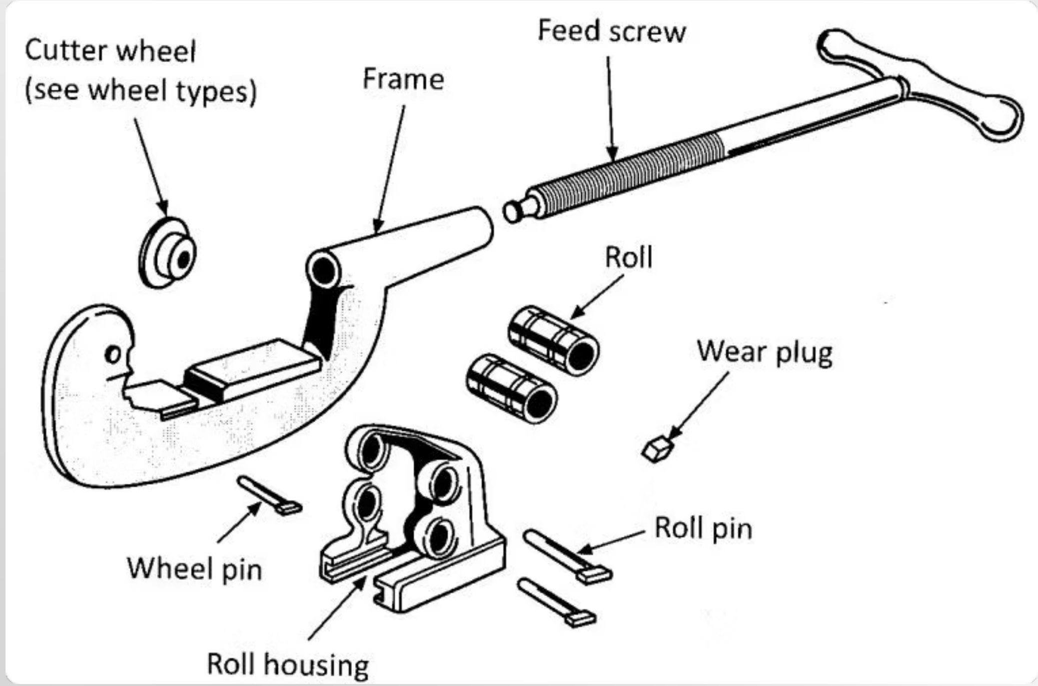
Understand the various types of tools available including screwdrivers, pliers, wrenches, hammers, and specialized pipe tools

Tool Safety

Follow proper safety procedures when using tools to protect yourself and others

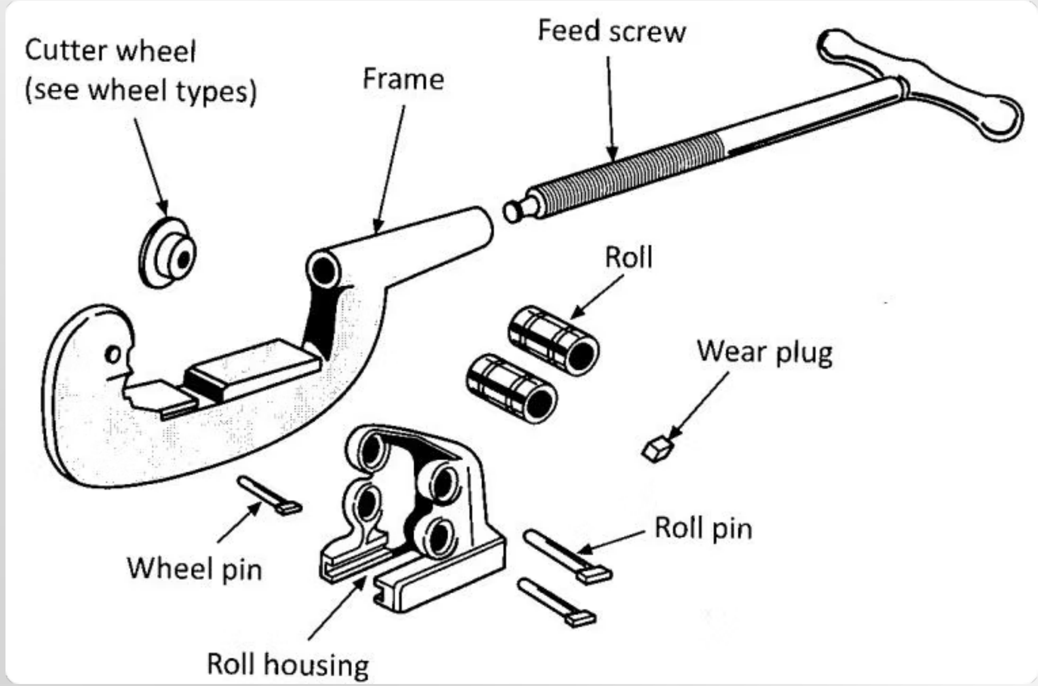
Tool Maintenance

Regularly clean, lubricate, and properly store tools to ensure long working life and optimal performance



Pipe Cutting and Threading Tools

A comprehensive guide to the essential tools used by gas technicians and fitters for cutting, reaming, and threading pipes.



Types of Pipe Cutters

Standard Wheel-and-Roller Cutters

Features a cutting wheel and supporting rollers to distribute pressure evenly around the pipe during cutting.

3-Wheel or 4-Wheel Cutters

These cutters have no rollers, only cutter wheels, making them ideal for use in confined spaces.

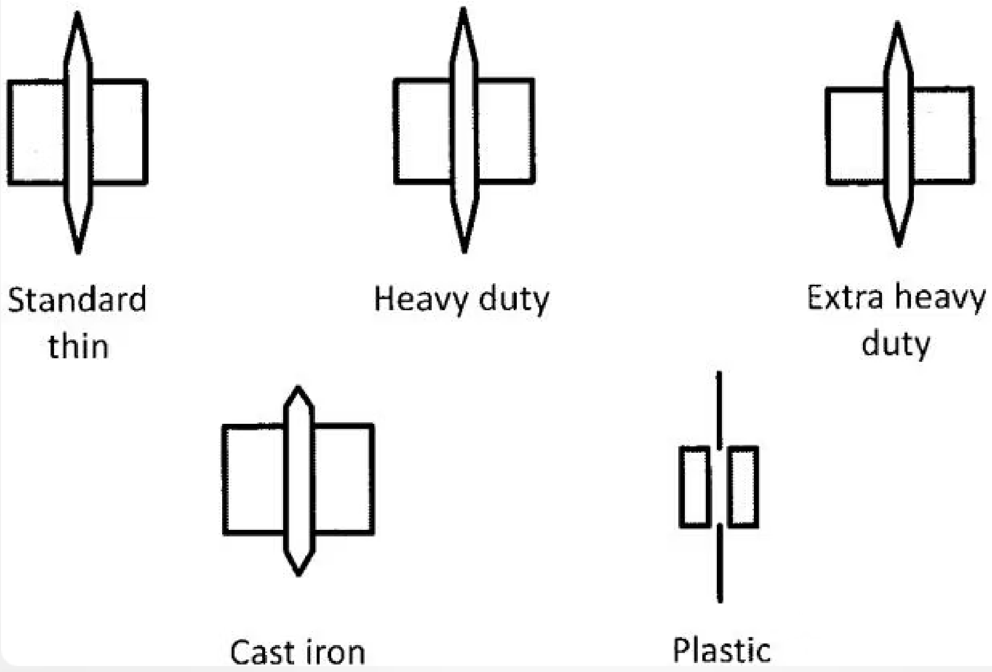
Pipe cutters are essential tools for gas technicians and fitters, allowing for clean and precise cuts on various pipe materials.

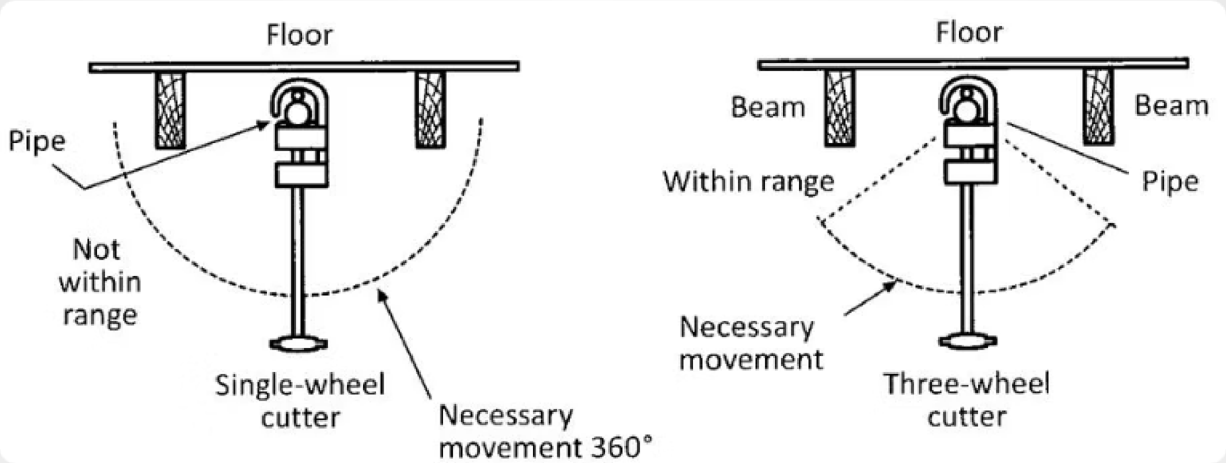
Cutter Wheel Selection

Type	Designed for
Standard thin wheel	Cutting ordinary steel pipe.
Stronger wheels	Cutting heavier or cast-iron pipe.
Very thin wheel	Cutting plastic pipe.

Before using a cutter wheel, always inspect it to make sure that it is not blunt or damaged. A blunt or dulled cutter tends to crush rather than cut the pipe.

Figure 2-24
Types of cutter wheels





Rotation Requirements for Pipe Cutters

360°

Single-Wheel Cutter

Wheel-and-roller cutters require a full rotation around the pipe

120°

Three-Wheel Cutter

Requires just over 120° of rotation, making it ideal for confined spaces

The amount of rotation needed varies by cutter type, which determines which tool is most appropriate for different working conditions.

Heavy-Duty Pipe Cutters

Type A

Cuts pipe sizes ranging from 1/8 in to 1-1/4 in.

Another model cuts pipe sizes NPS 1/8 to NPS 2.

Type B

Has a second handle for leverage by two people.

Cuts pipe sizes ranging from NPS 2 to NPS 6, depending on the model.

Heavy-duty cutters can function as single wheel-and-roller cutters for all-around work. For cutting in confined areas, replacing the two rollers with cutter wheels can convert these cutters to three-wheel cutters.

Three-Wheel Cutters

Requires Less Rotation

Because of the smaller amount of rotation needed with the three-wheel cutter, it is useful in confined spaces.

Requires More Care

You must take more care when starting a cut with the three-wheel cutter to make sure the cut is straight.

Leaves More Burr

This cutter also leaves more of an outside burr. You must remove the burr on every cut to avoid trouble with damaged thread or pipe dies.

Figure 2-27
Four-wheel cutters
age courtesy of RIDGID®; RIDGID® is the registered trademark of the Ridge To
Company.

Four-Wheel Cutters

Type	Description	Pipe Capacity
A	Has a short handle for extra-tight areas where only a 130° turn can be made.	NPS 3/4 to NPS 2
B	Has the second handle. Two people may use this for cutting large pipe sizes in confined areas.	NPS 2-1/2 to NPS 4

The four-wheel cutter facilitates work in areas where a complete turn is not possible, making it an essential tool for working in confined spaces.

Heavy-Duty, Wide-Roll Cutters

Extra-Wide Rollers

Prevent the cutter from wobbling during the cutting operation

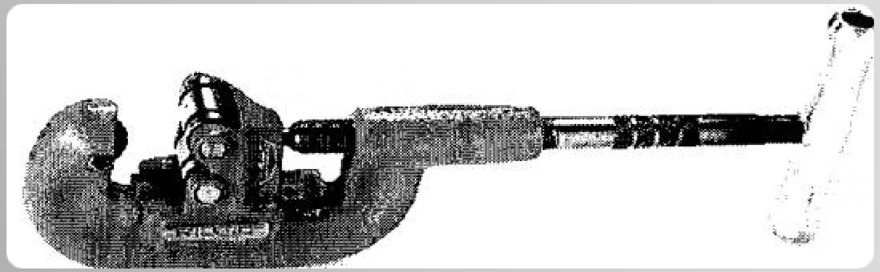
Longer Body

Designed to rest on the machine while cutting

Pipe Capacity

NPS 1/8 to NPS 2

Gas technicians/fitters use the heavy-duty, wide-roll cutter with power vises for stable and precise cutting operations.



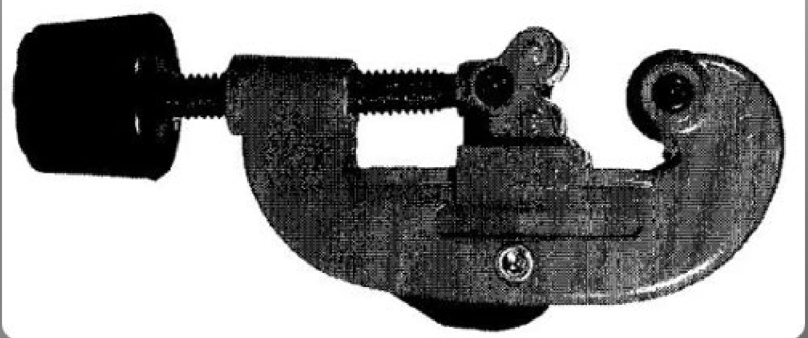


Figure 2-29
Tubing cutter

Tubing Cutters

Clean, Square Cuts

Helps make clean, square cuts on copper, brass, aluminum, and thin-walled conduit.

Built-in Reamer

These cutters commonly have a fold-away reamer attached to them.

Caution!

It is extremely important that you do not use tubing cutters to cut pipe, as the cutting wheels will become totally useless.

Crosscut Saw

Function

To cut across the grain of wood

Design

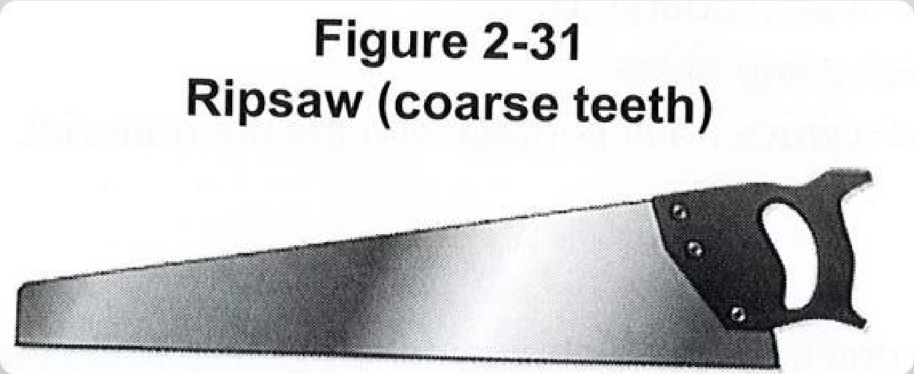
The familiar handsaw with teeth designed for cross-grain cutting

Limitation

Do not use it on metal

The crosscut saw is a basic but essential tool for woodworking tasks that may be required during pipe installation projects.

Figure 2-30
Crosscut saw (fine teeth)



Ripsaw

Purpose

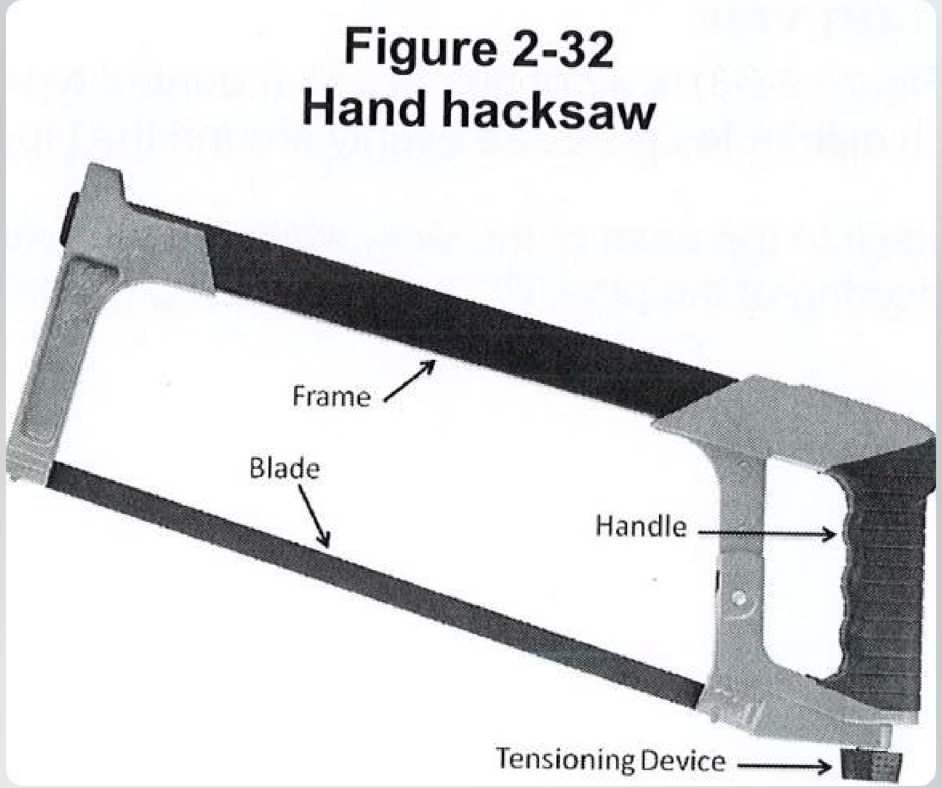
A ripsaw helps cut along the length of the grain of wood.

Limitation

Do not use it on metal.

Blade Design

The rip saw has a coarser blade (fewer teeth/inch) than the crosscut saw.



Hacksaw

Primary Uses

Gas technicians/fitters use a hand hacksaw primarily to cut metal, as well as for cutting threaded rod and shaping such things as sheet metal and strap hangers.

Frame Types

Hacksaw frames may be fixed or adjustable. Fixed frames are more rigid, but adjustable frames enable the use of different blade lengths.

Blade Orientation

Usually, you may orient the blade in line with the frame or at an angle 45° or 90° angle to it.

Hacksaw Blade Types

All-Hard (Rigid) Blades

- Made of fully hardened steel
- Used to cut tough materials such as alloy and tool steel
- Are brittle and break easily

Flexible Blades

- Are either carbon steel or bi-metal and do not break easily
- Carbon steel blades are economical and are used to cut mild steel, copper, brass, and aluminum
- Bi-metal blades are used to cut all types of metal

The blades are 10 in or 12 in (250 mm or 300 mm) in length and come in different types for various applications.

Hacksaw Blade Selection

1 Consider Teeth Count

The number of teeth per inch determines the coarseness of the blade.

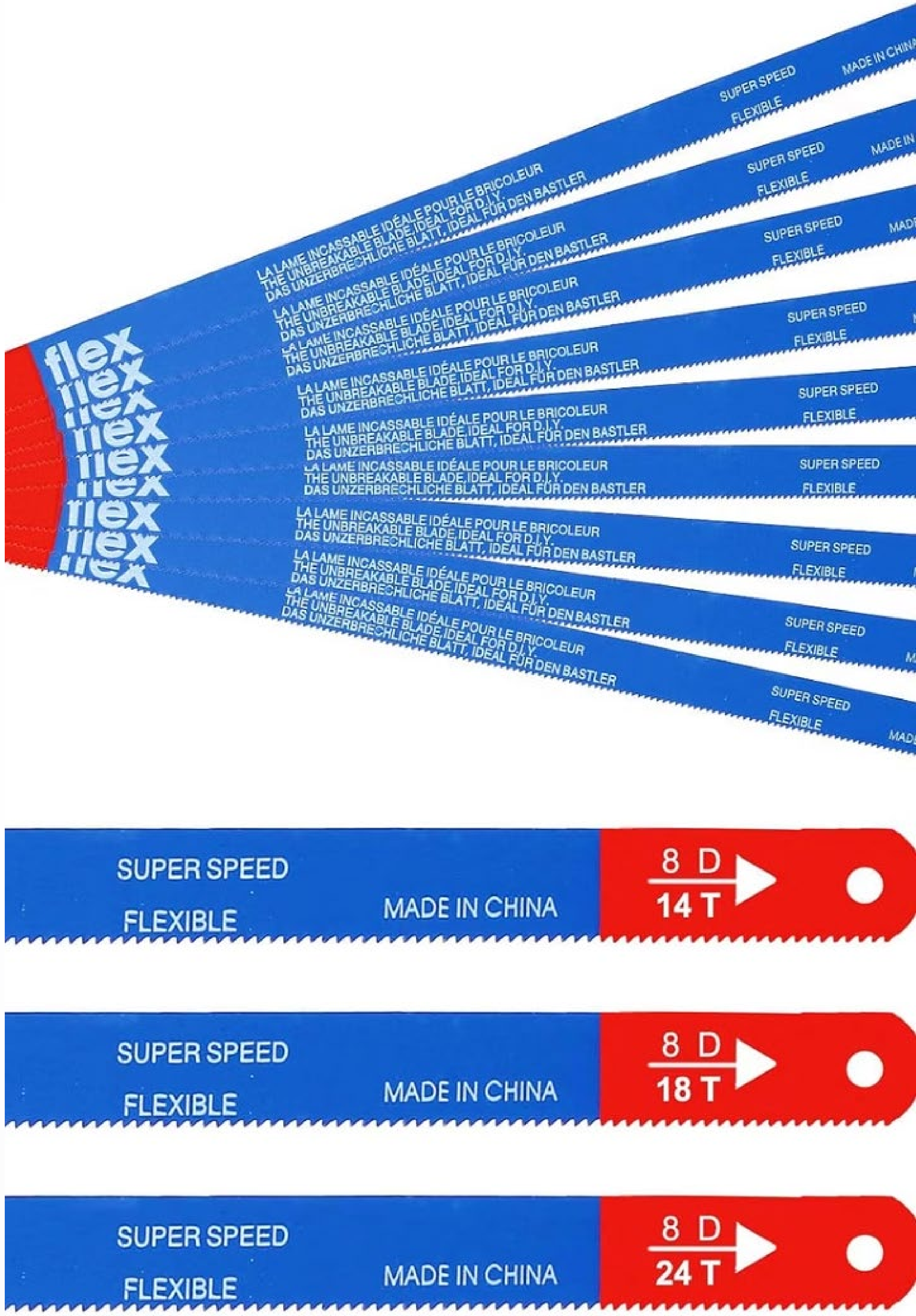
2 Match to Material Thickness

To cut thick materials, choose a coarse blade. For thin materials, choose a fine blade.

3 Ensure Proper Contact

At least two teeth should always be in contact with the cut material.

Selecting the right hacksaw blade for the job ensures cleaner cuts, longer blade life, and more efficient work.



Pipe Vises Overview

Purpose

Pipe vises are holding devices that gas technicians/fitters use while cutting, reaming, and threading pipe.

Bench-Mounted

Some are attached to workbenches for stationary use in workshops.

Portable Stands

Others are mounted on portable stands for use at the job site.

Secure Grip

All provide a secure hold on pipes during various operations.

Top-Screw Bench Chain Vise

Chain Advantage

Its main advantage lies with the holding chain, which distributes pressure evenly around the pipe.

Secure Anchoring

The crank handle anchors itself to the base of the vise.

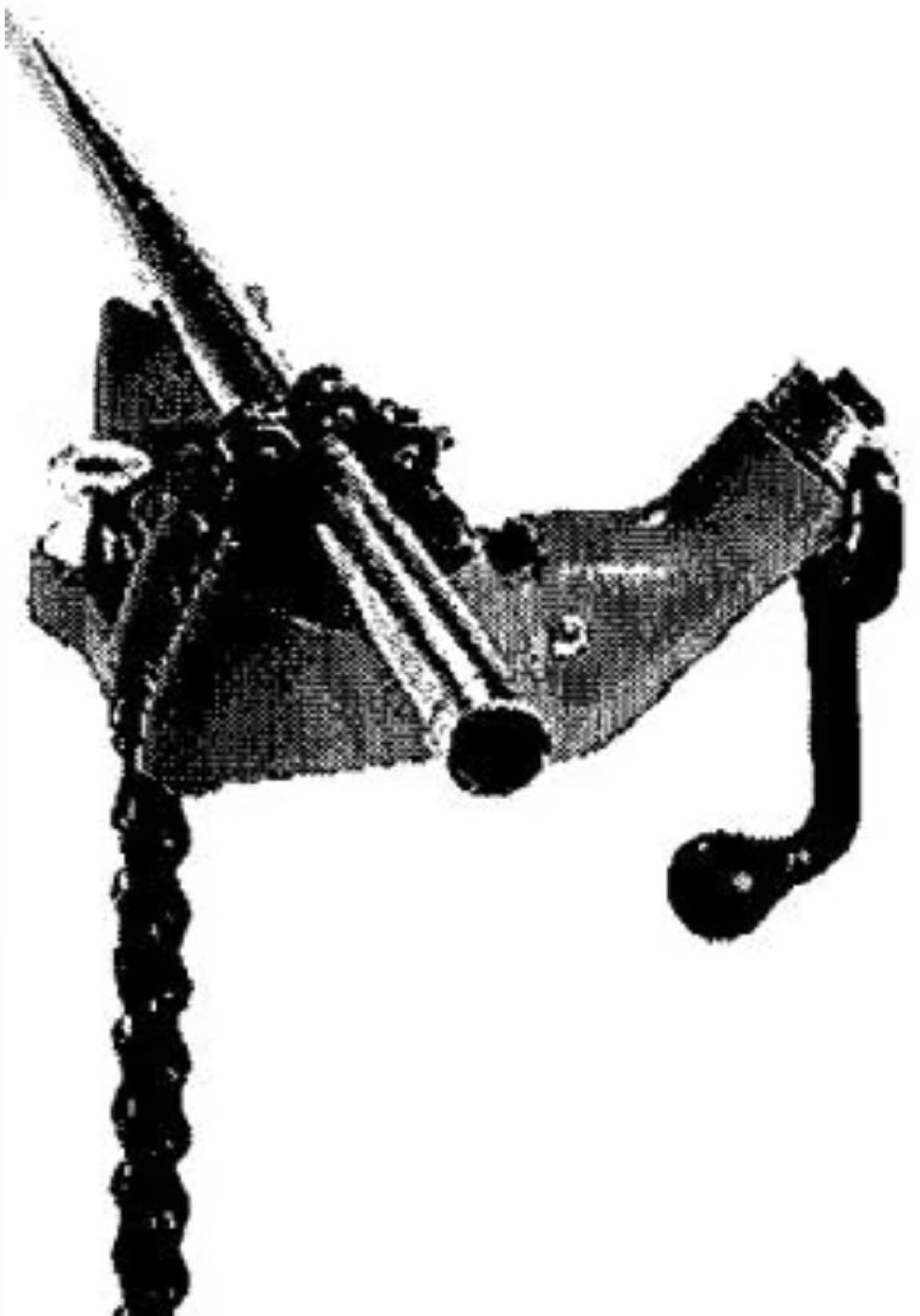
Pipe Protection

The toothless jaws have a special neoprene coating to avoid scoring of the pipe.

Capacity

Pipe capacity is up to NPS 8.

The top-screw chain vise is a popular bench-mounted type. There is also a bottom-screw chain vise available.



Tri-Stand Chain Vise

Large Base

Provides stability during pipe work

Tool Tray

Features a slotted tool tray for convenience

Portable

Complete, portable workbench

Capacity

Holds pipe up to NPS 5

The gas industry particularly likes this type because the chain holds a pipe snugly, with uniform pressure.

Top-Screw, Stand Chain Vise

Design Feature

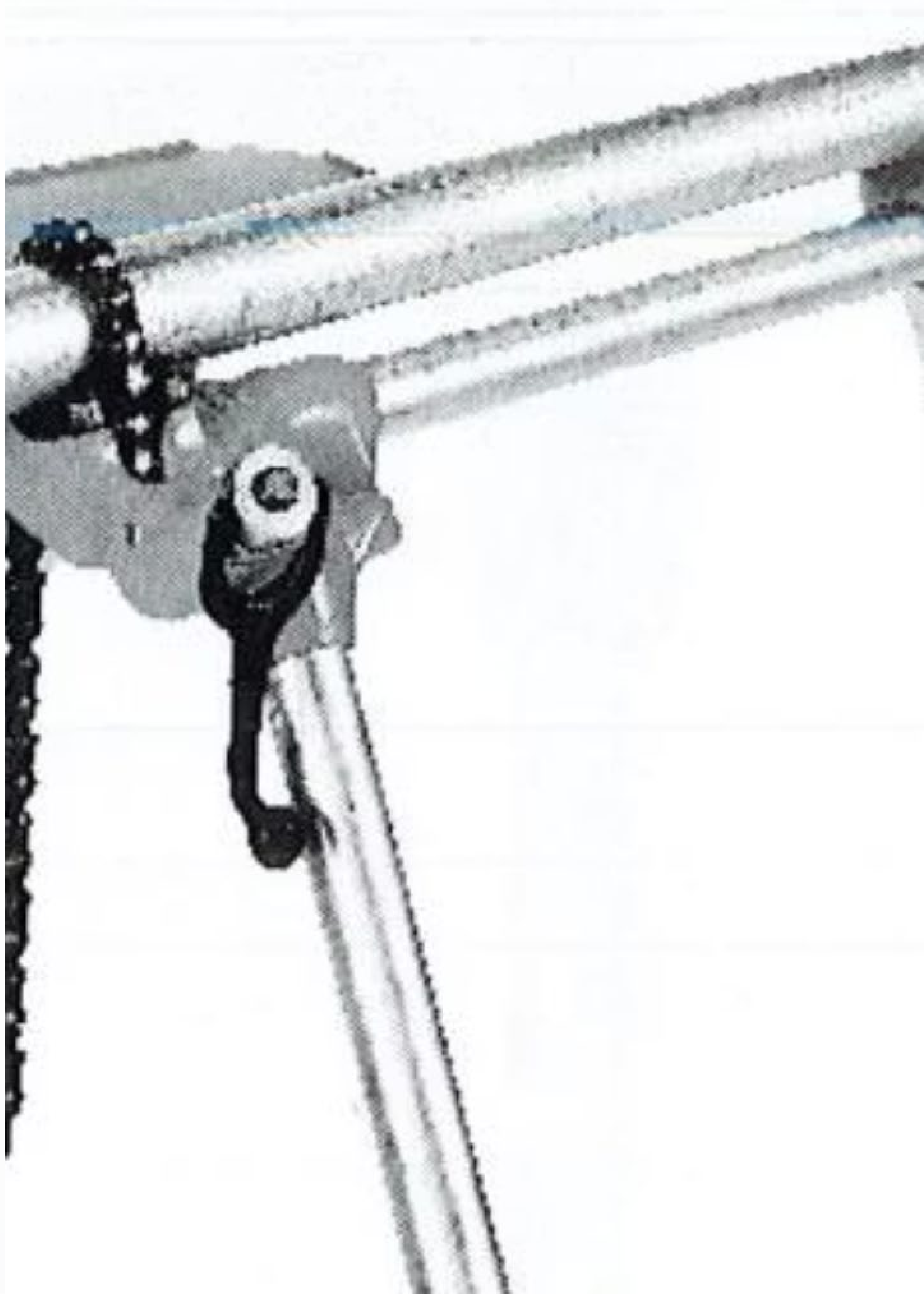
A pipe connects two pairs of legs that make the top-screw, stand chain vise handy for working on long lengths of pipe that require support.

Customization

Manufacturers must often tailor each of the legs and connecting pipe for each job because suppliers do not provide these parts along with the vise.

Capacity

The vise will hold a maximum pipe capacity of NPS 5.



Pipe Reamers Introduction

Purpose

Reamers help remove the burr from the inside surface of a pipe after you cut the pipe with cutters.

Objective

The objective is a smooth finish no smaller than the inside diameter of the pipe for unrestricted fluid and gas flow.

Operation

You can do reaming by hand, but certain types of reamers specifically function for power vises.

Sequence

Reaming always comes before threading to avoid deforming the threaded end.

Straight, Fluted, Ratchet Reamer

Efficiency

This reamer works fast and clean with light pressure.

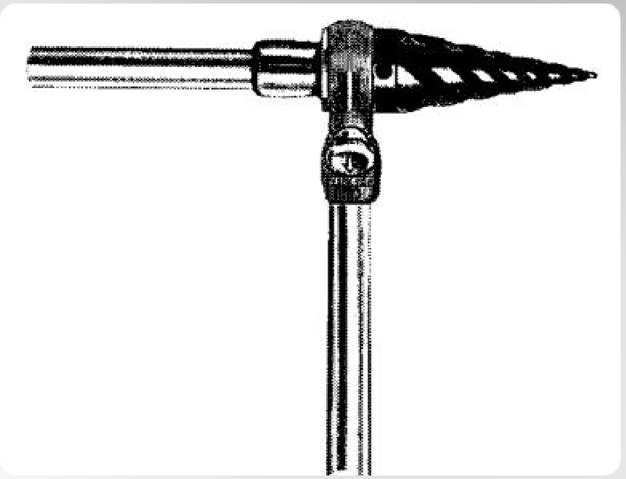
Versatility

It works for either hand or power reaming.

Safety

Of the three tools, it is the only one that is safe for power equipment.

Two models of the straight ratchet reamer are available. One has a pipe capacity of NPS 1/8 to NPS 2. The other has a pipe capacity of NPS 3/8 to NPS 3.



Spiral Ratchet Reamer

Hand Use Only

The function of spiral ratchet reamer is for hand use only.

Safety Warning

It is unsafe to use with a power vise.

Pipe Capacity

Such reamers can handle a pipe capacity up to NPS 4.

Injury Risk

You should not use hand spiral reamers with power vises, as the reamer may bind in the pipe and pull away from your hand, possibly causing injury.

Understanding Threads

Purpose

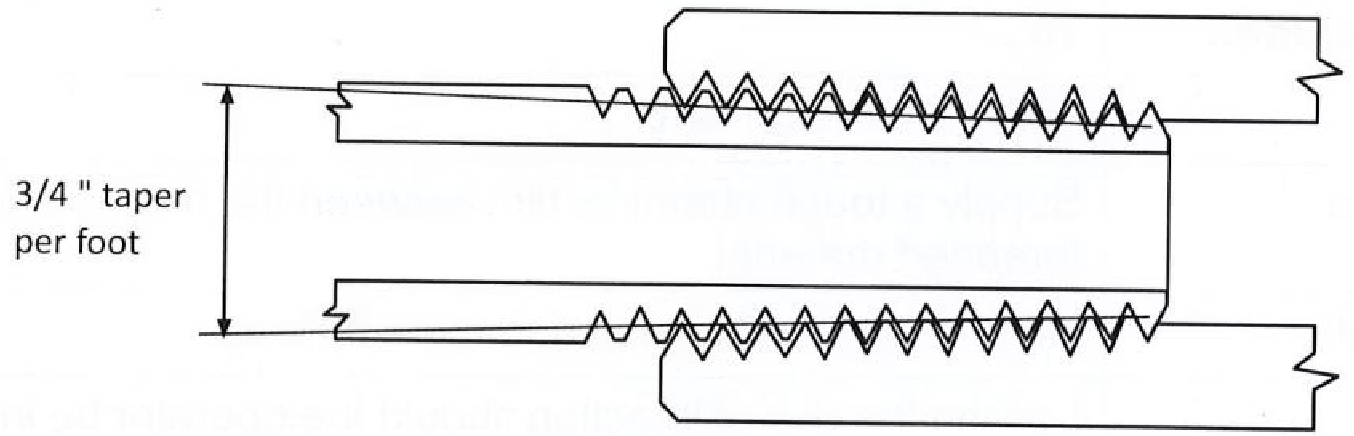
Gas technicians/fitters use internal and external threads in combination to make mechanically sound and leak proof connections.

Types

Threads may be cut straight or tapered, each serving different purposes in piping systems.

Proper threading is essential for creating secure, leak-proof connections in gas piping systems.

Straight vs. Tapered Threads



Straight Threads

- Called parallel because the peaks of the threads all have the same diameter
- Bolts usually have straight threads
- Piping connections that need not be leak proof often use straight threads

Tapered Threads

- Tapered threads, both internal and external, mesh together when tightened securely, producing a leak proof joint
- Standard piping threads have a taper of 3/4 in per foot

Thread Direction and Sizing

Right-Hand Threads

The fitting is screwed onto the threaded pipe in a clockwise motion.

Left-Hand Threads

The fitting is screwed onto the threaded pipe with a counter-clockwise motion.

Default Direction

A thread is assumed to be right-hand unless designated otherwise.

Size Variation

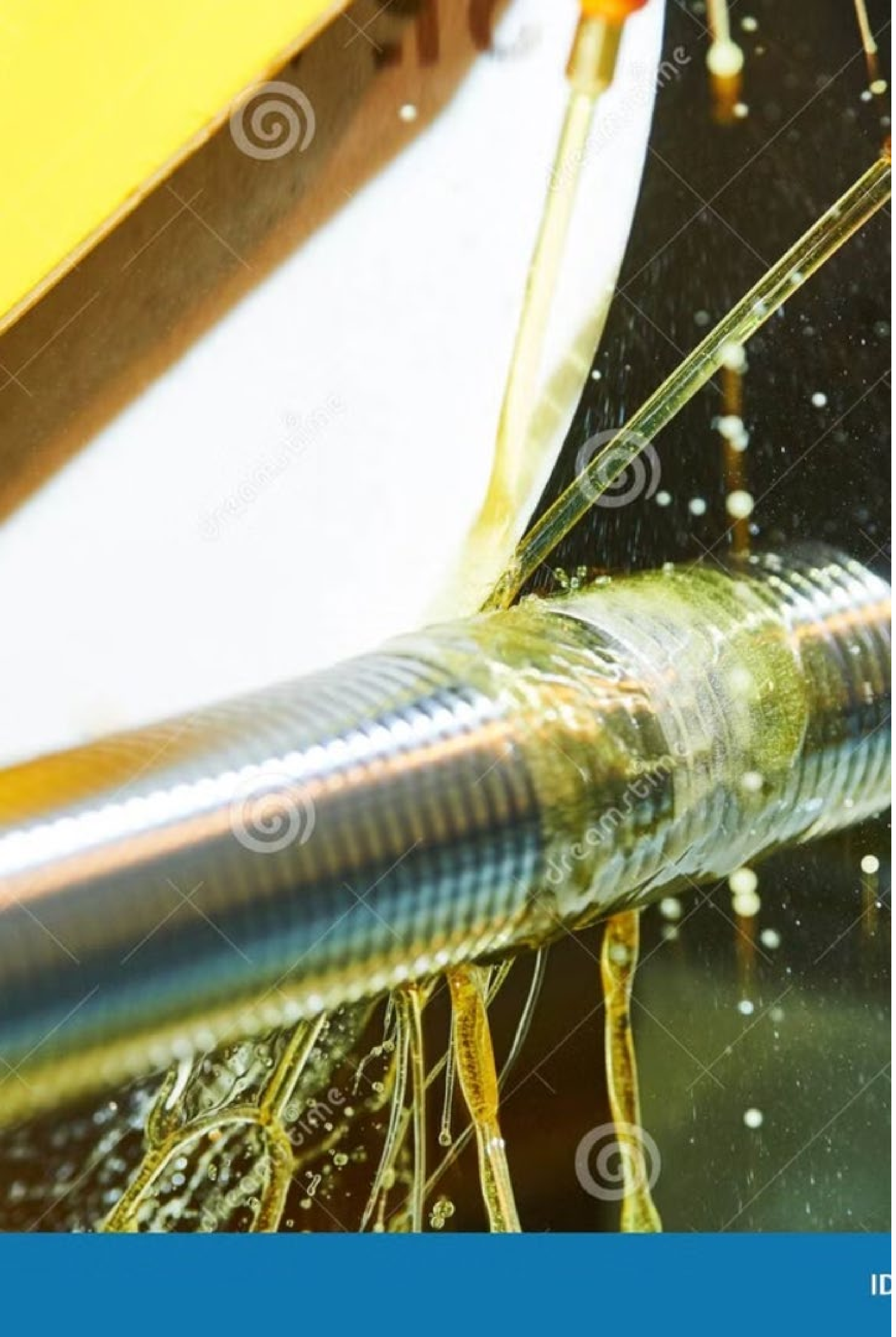
The size of thread varies for different sizes of pipe; the larger the pipe size, the larger the size of the thread.

Male Thread O.D. mm	Male Thread O.D. inches
9.7	0.38
13.2	0.52
16.5	0.65
20.8	0.82
22.4	0.88
26.4	1.04
33.0	1.30
41.9	1.65
47.8	1.88
59.7	2.35

Thread Count by Pipe Size

NSP Pipe	Threads/Inch
1/8	27
1/4, 3/8	18
1/2, 3/4	14
1 to 2	11-1/2
2-1/2 to 12	8

When you screw a pipe to a fitting, 7 to 8 threads are engaged (a little more for pipe sizes larger than NPS 1-1/4). Therefore, you can measure or calculate the approximate thread engagement for the various sizes of pipe. This is useful in determining the length of pipe to cut when you know the center-to-centre measurement.



Thread Cutting Oil

Purpose

Thread cutting oil helps produce accurate work and a smooth finish, during a threading operation.

Functions

The oil covers the pipe and the die to reduce friction, cool both the tool and the pipe, and flush away metal chips.

Thread cutting oils are either clear or dark and produce the same result when working with either power-driven or hand tools.

Thread Cutting Oil Ingredients

Ingredients	Purpose
Fatty oil	Provide an even film.
Sulphur/chlorine	Supply a tough chemical film between the cutting edges and the threaded material.
Anti-foam agent	Reduce surface tension and foam buildup.
Germicide	Lessen the risk of infection should the operator be injured.

Thread Cutting Oil Usage

1 Lubrication and Cooling

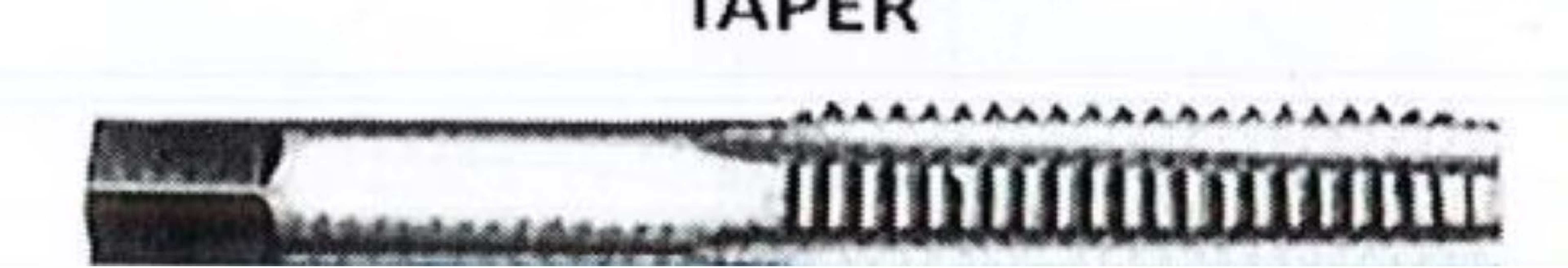
Thread cutting oil lubricates and cools the threads during the threading operation. A dirty or poor-grade of cutting oil can result in poor thread quality.

2 Maintenance

Clean metal shavings and other debris from the chip tray of the oiler. Check the level and quality of the thread cutting oil. Replace or add oil if necessary.

3 Not a Tool Lubricant

You should not confuse thread cutting oils with the oils used to maintain the condition of tools. They are not, in that sense, a lubricant.



Pipe Taps

Function

Pipe taps help cut or repair internal pipe threads. The process is called tapping and is usually done by hand using a special wrench to hold and turn the tap.

Preparation

Before attempting to tap new threads in a plain hole, you should taper the hole with a taper pipe reamer to properly shape the hole.

Specifications

Sizes range from NPS 1/8 to NPS 2. Manufacturers usually stamp the diameter and pitch (the number of threads per inch) on the shank.

Design Features

The flutes on a tap provide a space between the cutting edges to catch metal chips. The square end of the tap provides a sturdy grip for the tap wrench.

Pipe Dies Introduction

Purpose

Gas technicians/fitters use dies to cut the external threads on pipe fitting- a process known as threading.

Die Head

A die head holds the cutting dies in place.

Handle

Mounted on the die head is a handle of suitable length for turning often with a ratchet assembly for convenience and ease of operation.

Design Feature

Dies have flutes or spaces between the cutting edges to provide space for metal chips to escape during the threading operation.

There are two main types of dies: full-width and receding.

Full-Width Dies

Design

The width of the dies is equal to the length of the thread to be cut

Operation

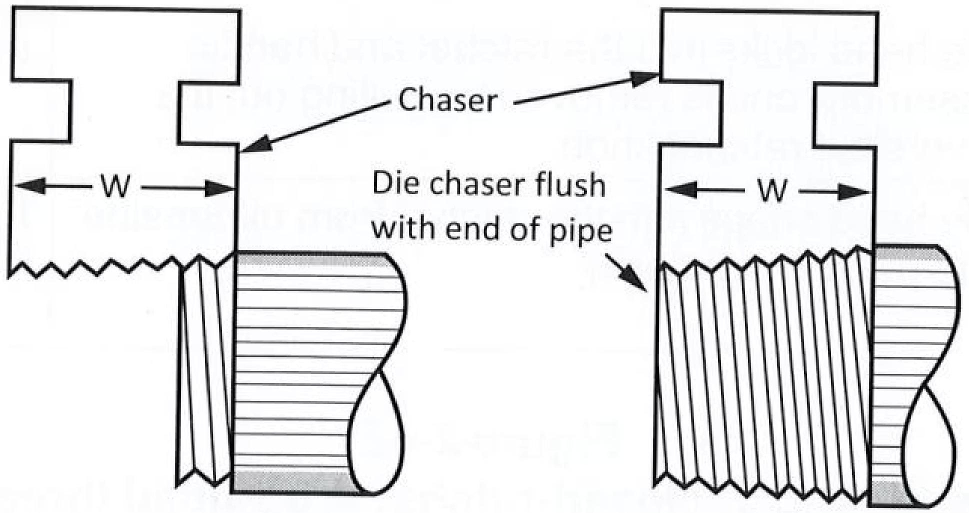
The die moves along the pipe as it cuts the thread

Completion

When the outer edge of the die is flush with the end of the pipe, the thread is complete

This applies to taper threads only. Full-width dies facilitates threading of smaller pipe sizes, where less effort is required.

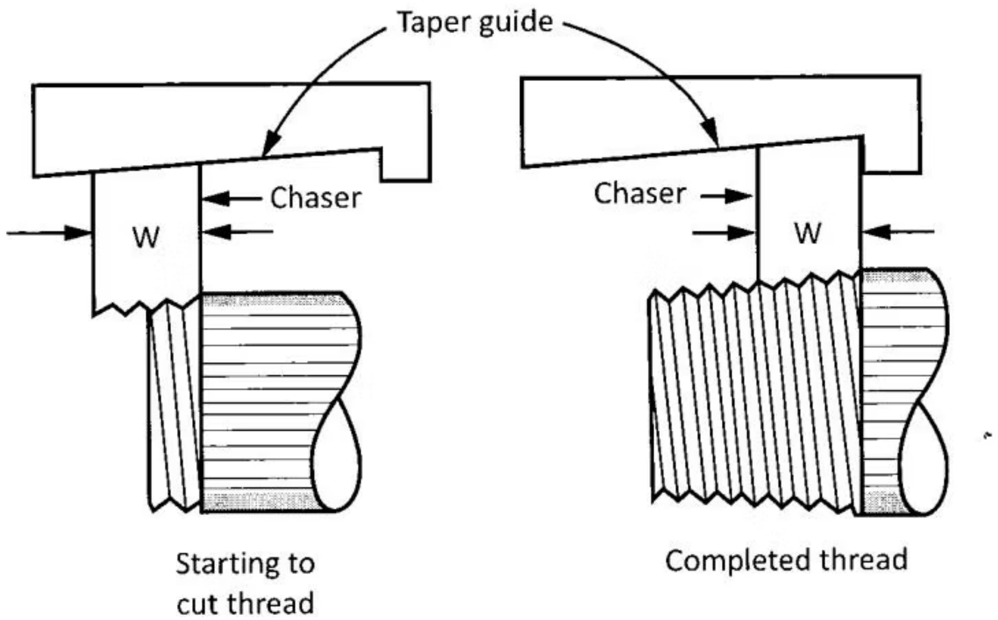
Figure 2-40
Full-width die



Starting to cut thread

Completed thread

Figure 2-41
Receding die



Receding Dies

Design

In receding dies, the width of the dies is considerably less than the length of the thread to be cut.

Operation

The die must travel along the pipe to cut the thread, and as the die moves along the pipe, it must recede from the centre line of the pipe in order to cut a tapered thread.

Application

Receding dies usually help thread larger pipe where there is considerable surface area to cut.

Hand Threaders Overview

Industry Preference

The gas industry prefers the ratchet type of threader to other hand methods.

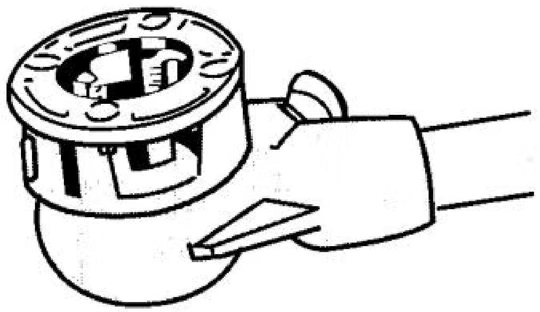
Ergonomic Advantage

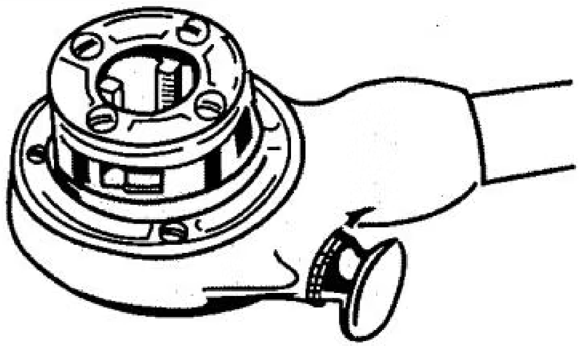
Body weight can help turn the full-width dies while standing to one side of the pipe.

Main Types

Ratchet, drop-head hand threaders are among the most common types used.

Ratchet, Drop-Head Hand Threaders





Exposed-Ratchet, Drop-Head Threader

- More widely used than the enclosed type
- Die head locks into the ratchet and handle assembly
- Removed by pulling out the reversible ratchet knob
- Designed for pipe sizes ranging from NPS 1/8 to NPS 1

Enclosed-Ratchet Drop-Head Threader

- Die head snaps into the ratchet from either side
- Pushes out easily
- Pipe size capacity is from NPS 1/8 to NPS 2

Drop-head threaders are quick and easy to use for small jobs or in close quarters. The dies are interchangeable. In both models, you can reverse the dies for close-to-the-wall threading. You can also use drop-head threaders with power vises.

Ratchet Threader Maintenance

Inspection

Inspect the threader before use

Replacement

Replace dies or any other part that shows damage or wear

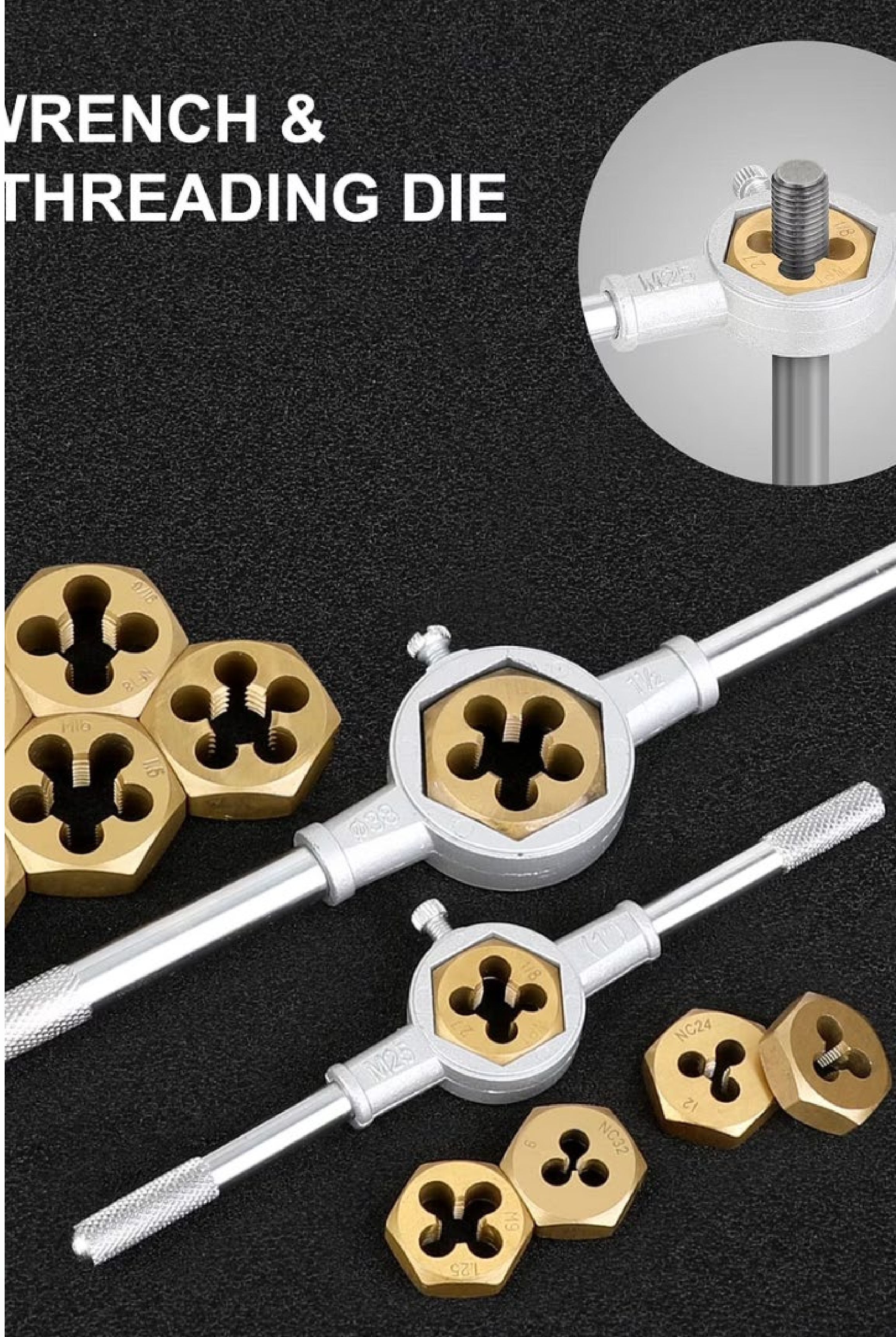
Cleaning

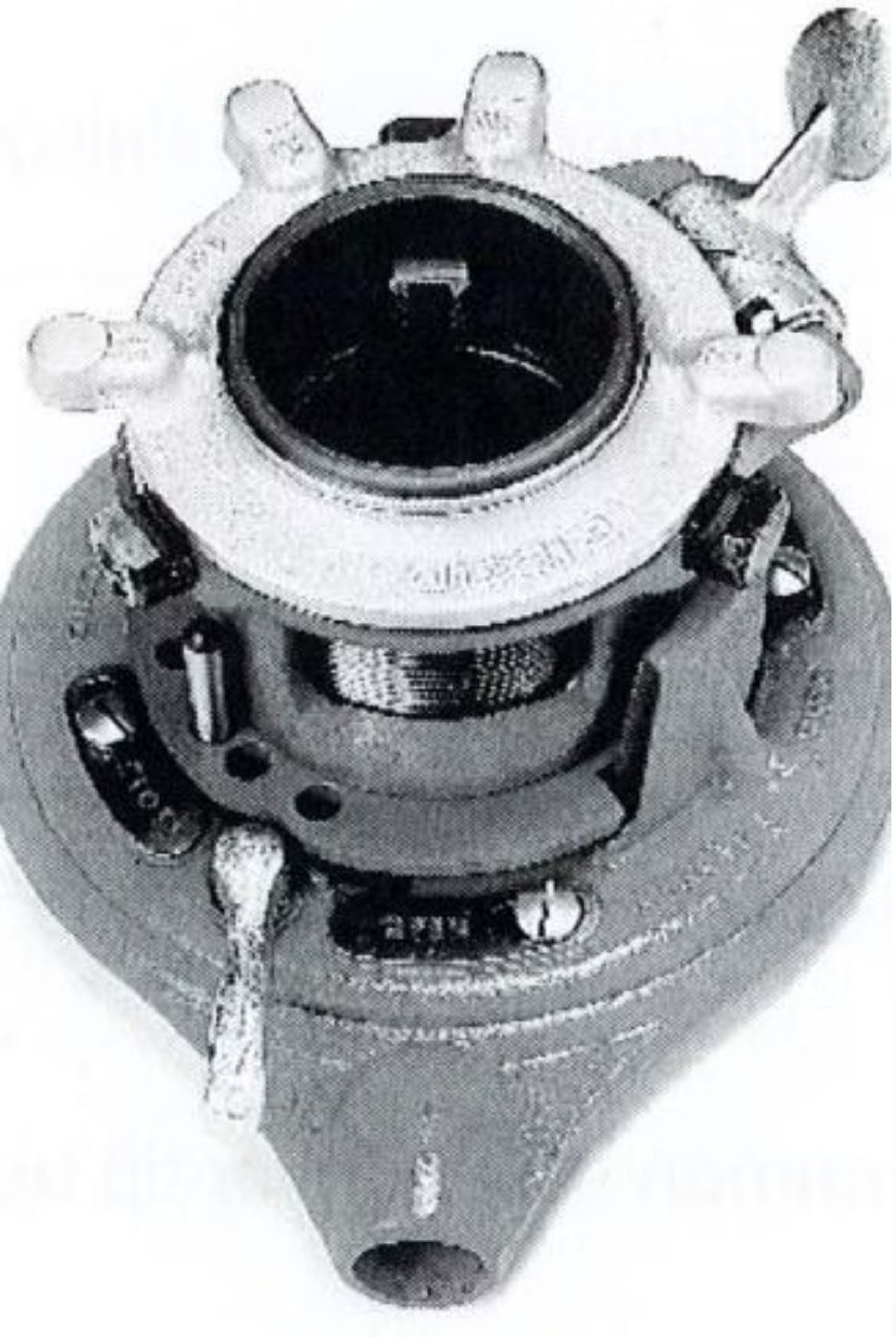
Keep dies clean from debris and metal shavings

Lubrication

Apply proper thread cutting oil during use

Proper maintenance of ratchet threaders ensures clean, accurate threads and extends the life of the tool.





Jam-Proof Ratchet Threader

Die Type

The jam-proof ratchet threader uses receding dies.

Versatility

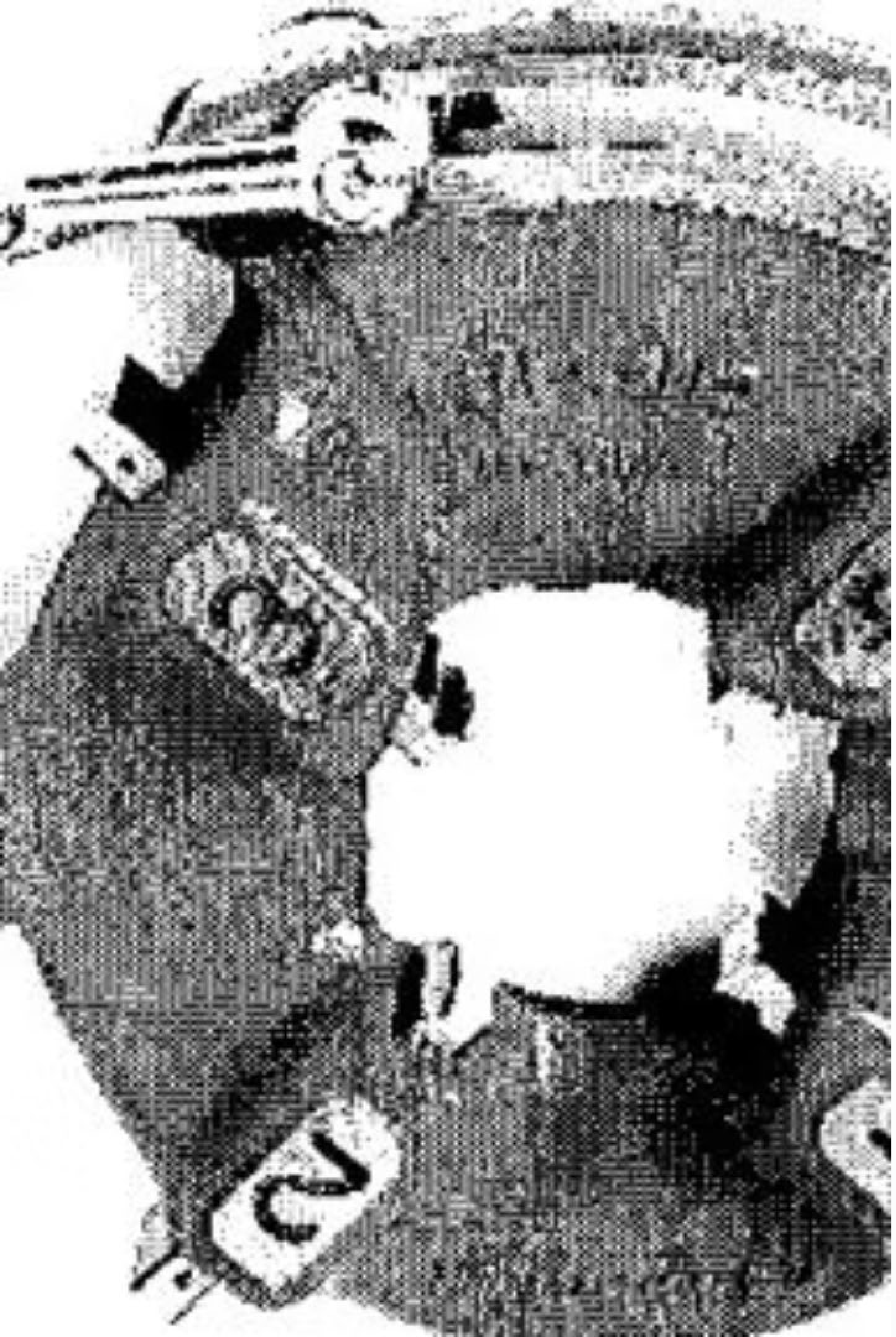
It is useful and quick for threading pipe between NPS 1 to NPS 2 size.

Adaptability

It uses one set of dies to thread different pipe sizes.

Safety Feature

After the thread is completely cut, its jam-proof action kicks out automatically to prevent damage caused by dies receding past their limit.



Quick-Opening Threader

Design Purpose

The quick-opening threader is designed for use on power equipment such as a power threading machine.

Key Feature

After you cut the thread to the required length, the die head has a lever to release the dies from the pipe, eliminating the need to stop and back off after the thread has been cut.

Die Head Styles

Mono-Die Head

Threads just one size of pipe.

Universal-Die Head

Adjustable—can use the same set of dies to thread NPS 1 to NPS 2 pipe or fit two other die sets to thread NPS 1/2 to NPS 3/4 pipe or NPS 1/4 to NPS 3/8 pipe.

Selecting the appropriate die head style depends on the variety of pipe sizes you need to thread and the frequency of use.

Thumb Drills

Purpose

Gas technicians/fitters use Thumb drills to drill out orifices

Precision

Allows for accurate sizing of gas orifices

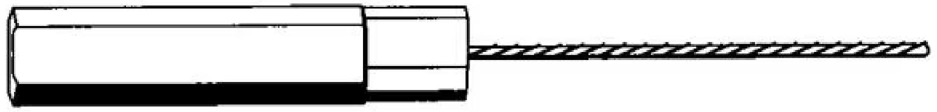
Manual Operation

Operated by hand for controlled drilling

Compact Size

Small enough for precise work in tight spaces

Figure 2-45
Thumb drill



Proper Pipe Cutting Technique

Select the Right Cutter

Choose the appropriate cutter type based on pipe material, size, and working space.

Inspect the Cutter Wheel

Ensure the cutter wheel is sharp and appropriate for the pipe material.

Mark the Pipe

Clearly mark where the cut should be made around the entire pipe.

Position and Tighten

Position the cutter on the mark and tighten it just enough to keep it in place.

Completing the Pipe Cut

Rotate the Cutter

Rotate the cutter around the pipe, tightening slightly after each complete rotation.

Apply Cutting Oil

Apply thread cutting oil to the cutting wheel to reduce friction and extend wheel life.

Continue Rotating

Continue the process until the pipe is completely cut through.

Remove Burrs

Use a reamer to remove any burrs from the inside of the pipe.

Pipe Threading Process

Cut the Pipe

Use the appropriate cutter to make a clean, square cut.

Ream the Pipe

Remove all burrs from the inside of the pipe.

Select Threading Tools

Choose the appropriate die and die head for the pipe size.

Thread the Pipe

Apply cutting oil and use the die to cut threads to the proper depth.

Clean the Threads

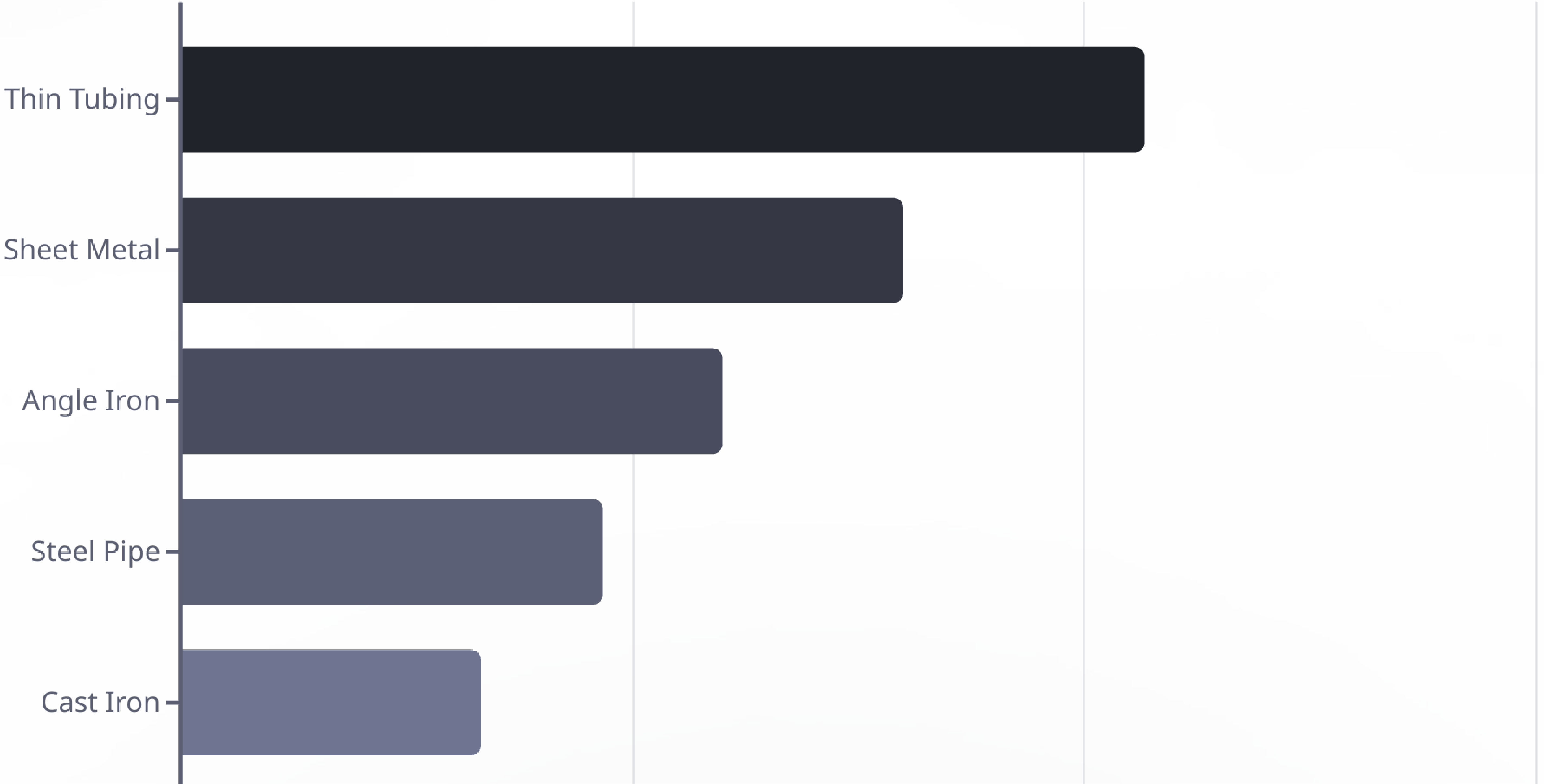
Remove any metal shavings and excess oil from the threads.

Choosing the Right Saw

Saw Type	Best Used For	Not Suitable For
Crosscut Saw	Cutting across wood grain	Metal
Ripsaw	Cutting along wood grain	Metal
Hacksaw	Metal, threaded rod, sheet metal	Thick wood

Selecting the appropriate saw for the material being cut ensures cleaner cuts, safer operation, and longer tool life.

Hacksaw Blade Selection Guide



Pipe Vise Selection Guide

Thread Cutting Oil Comparison

Clear Oils

- Better visibility of the threading process
- Less messy to work with
- Easier to clean up
- Often preferred for indoor work

Dark Oils

- Often contain more additives
- May provide better lubrication for tough materials
- Typically more economical
- Common in industrial settings

Both clear and dark thread cutting oils produce the same result when working with either power-driven or hand tools, with the choice often coming down to personal preference and work environment.

Pipe Threading Safety Guidelines

Wear Proper PPE

Always wear gloves, safety glasses, and appropriate clothing when threading pipe.

Secure the Pipe

Ensure the pipe is securely held in a proper vise before beginning threading operations.

Use Cutting Oil

Always use the appropriate thread cutting oil to reduce friction and heat.

Keep Area Clean

Regularly clear metal shavings to prevent injuries and maintain a safe work area.

Pipe Measurement and Marking

Measure Accurately

Use a tape measure or ruler to determine the required pipe length, accounting for thread engagement in fittings.

Mark Completely

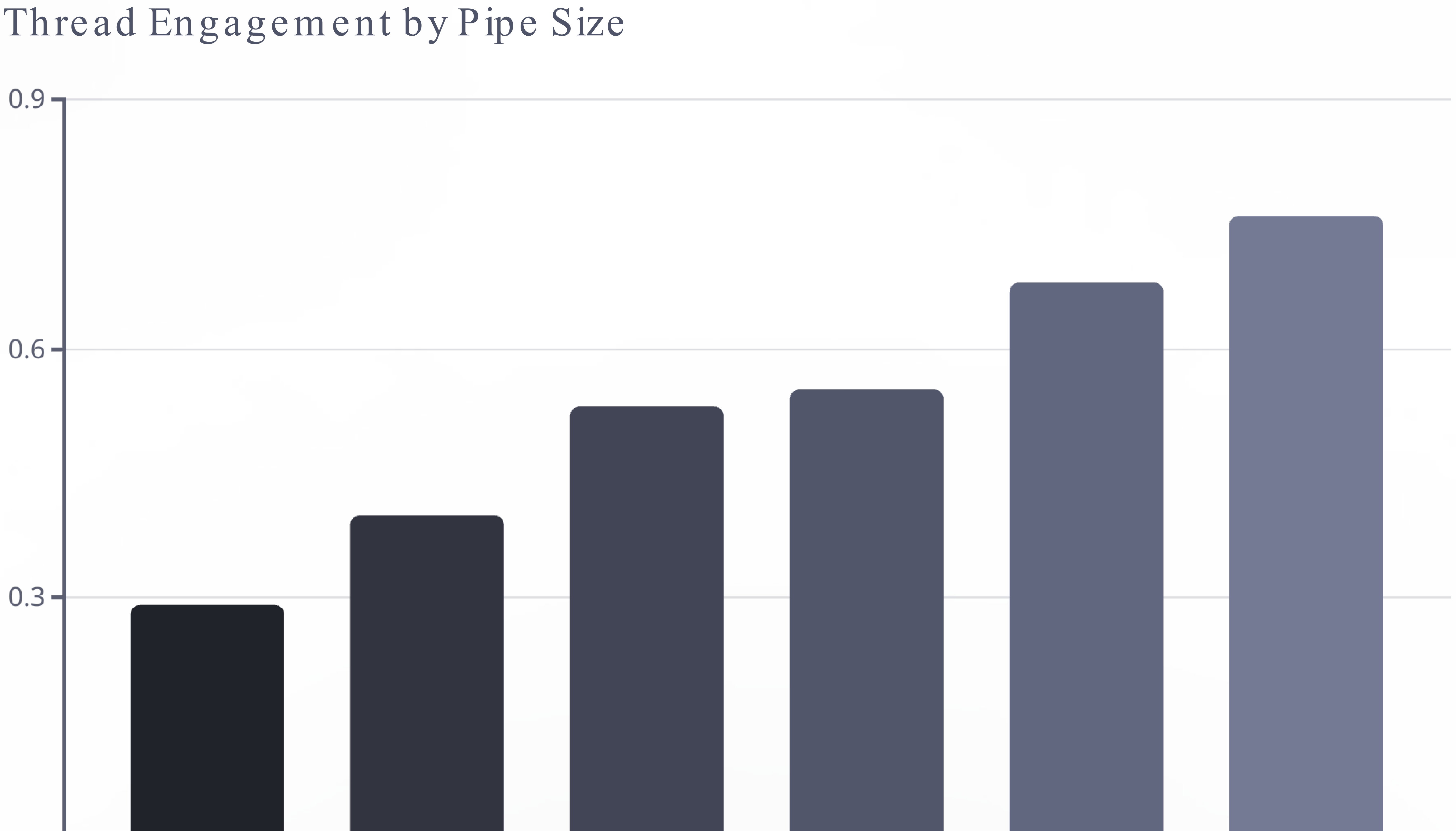
Mark the cutting line completely around the pipe to ensure a straight cut.

Consider Thread Engagement

Remember that 7-8 threads will engage when connected to a fitting, affecting the final assembled length.

Account for Fittings

Calculate the total assembled length including all fittings and thread engagement.


Thread Engagement by Pipe Size
0.9
0.6
0.3

Tool Maintenance Schedule

Tool	Maintenance Task	Frequency
Pipe Cutters	Inspect and replace wheels	Before each use
Reamers	Clean and oil	After each use
Dies	Clean, inspect, and oil	After each use
Vises	Clean jaws and lubricate moving parts	Weekly
Hacksaw	Replace blades	When dull or damaged

Regular maintenance of pipe cutting and threading tools ensures longer tool life, safer operation, and better quality work.

Common Pipe Threading Problems

Rough Threads

Caused by dull dies, insufficient cutting oil, or improper die adjustment. Replace dies, use more cutting oil, or adjust die properly.

Tapered Threads Too Long

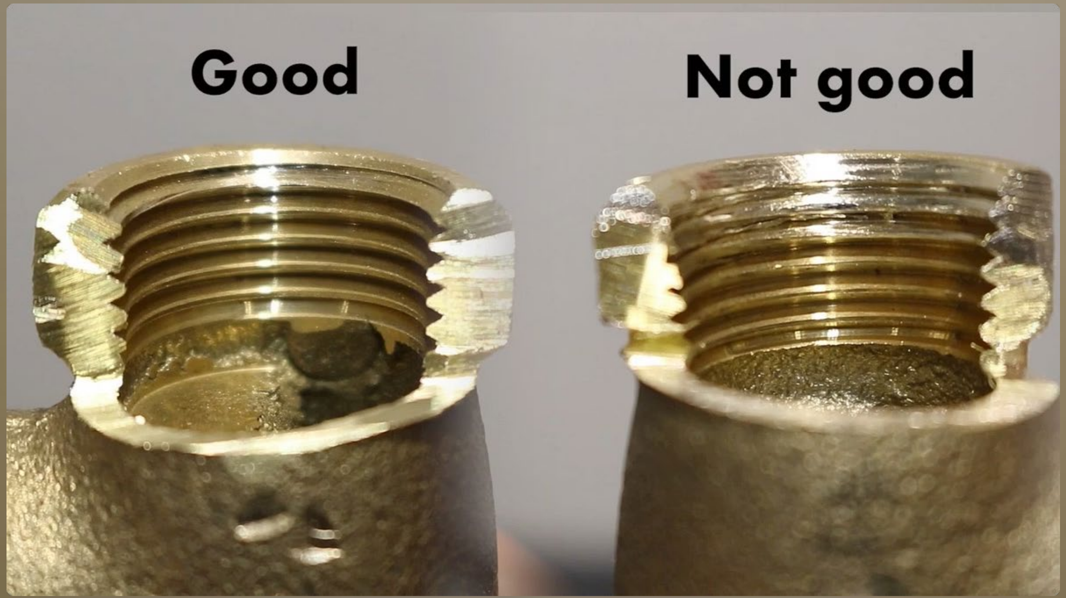
Caused by continuing to turn the die after the thread is complete. Stop threading when the die is flush with the pipe end for full-width dies.

Threads Too Shallow

Caused by improper die adjustment or premature removal. Adjust die properly and ensure complete threading.

Damaged Threads

Caused by cross-threading or forcing connections. Always start threads carefully and hand-tighten before using wrenches.



Pipe Cutting Tool Selection Guide

Steel Pipe

Use standard wheel-and-roller cutters with standard thin wheels

Cast Iron Pipe

Use heavy-duty cutters with stronger wheels

Copper Tubing

Use tubing cutters, never pipe cutters

Plastic Pipe

Use cutters with very thin wheels designed for plastic

Selecting the right cutting tool for the pipe material ensures clean cuts, extends tool life, and improves the quality of subsequent threading operations.

Pipe Threading Tool Evolution

1

Early Hand Tools

Simple dies and taps requiring significant manual effort

2

Ratchet Mechanisms

Introduction of ratcheting handles to reduce effort

3

Quick-Opening Dies

Development of dies that could be quickly released from the pipe

4

Power Threading

Introduction of electric and hydraulic threading machines

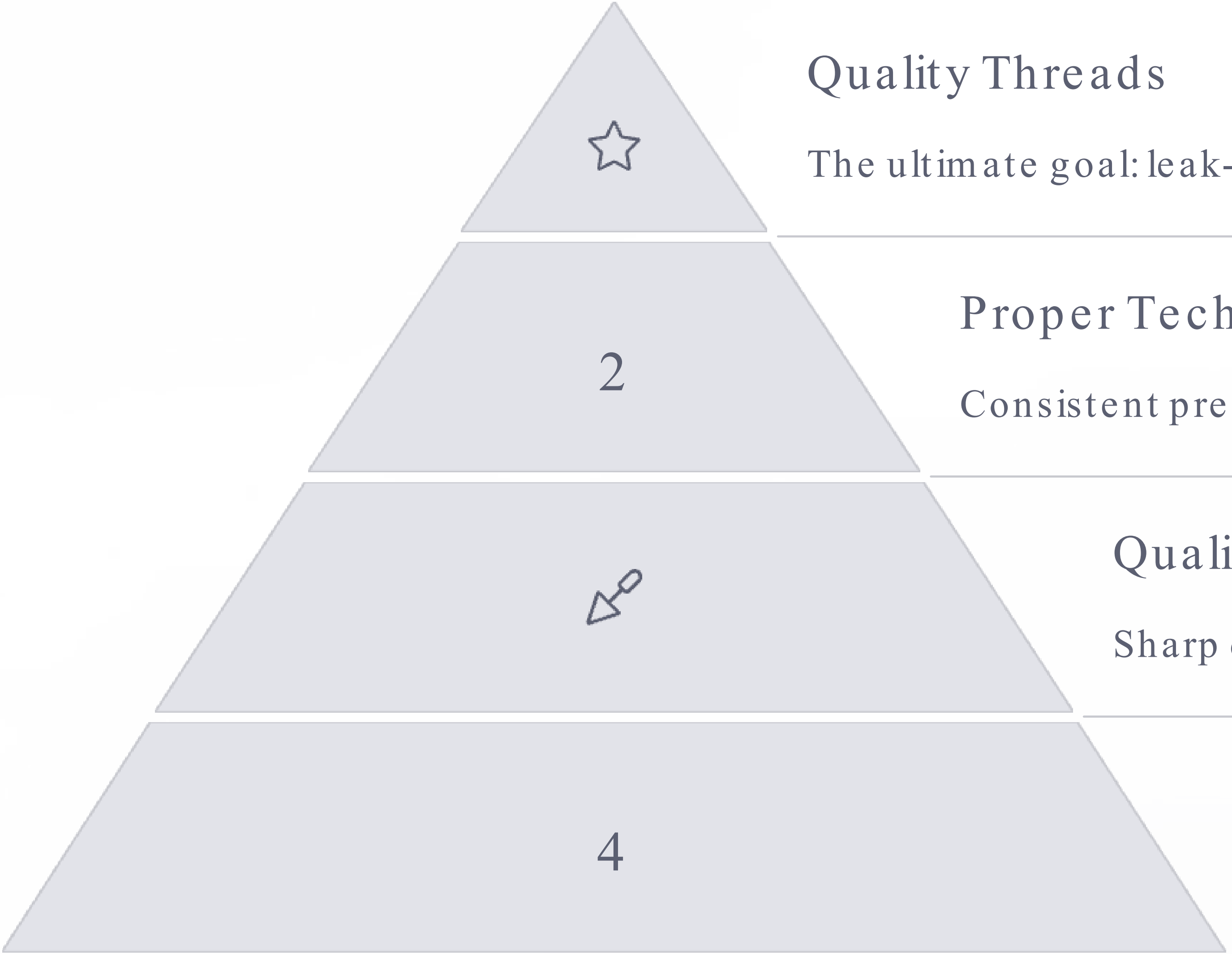
5

Modern Systems

Computerized, automated threading systems with precision control

The evolution of pipe threading tools has focused on improving efficiency, reducing physical effort, and increasing precision in thread creation.

Pipe Threading Best Practices



Quality Threads

The ultimate goal: leak-proof, strong connections

Proper Technique

Consistent pressure, steady rotation, adequate oil

Quality Tools

Sharp dies, appropriate cutters, proper vises

Thorough Preparation

Clean cuts, proper reaming, accurate measurements

Following best practices for pipe threading ensures high-quality, leak-proof connections that meet industry standards and provide long-term reliability in gas piping systems.

Essential Pipe Work Tool Kit





A complete pipe work tool kit for gas technicians and fitters should include quality pipe cutters, reamers, threading dies, vises, and accessories. Investing in professional-grade tools ensures better results, safer operation, and longer tool life.

CSA Unit 2

Chapter 3
Power Tools and Accessories for Gas Technicians

This presentation covers the essential knowledge gas technicians and fitters need regarding power tools and accessories. You'll learn about selecting the right tools for the job, safety requirements, and proper operation procedures for various power tools commonly used in the gas industry.

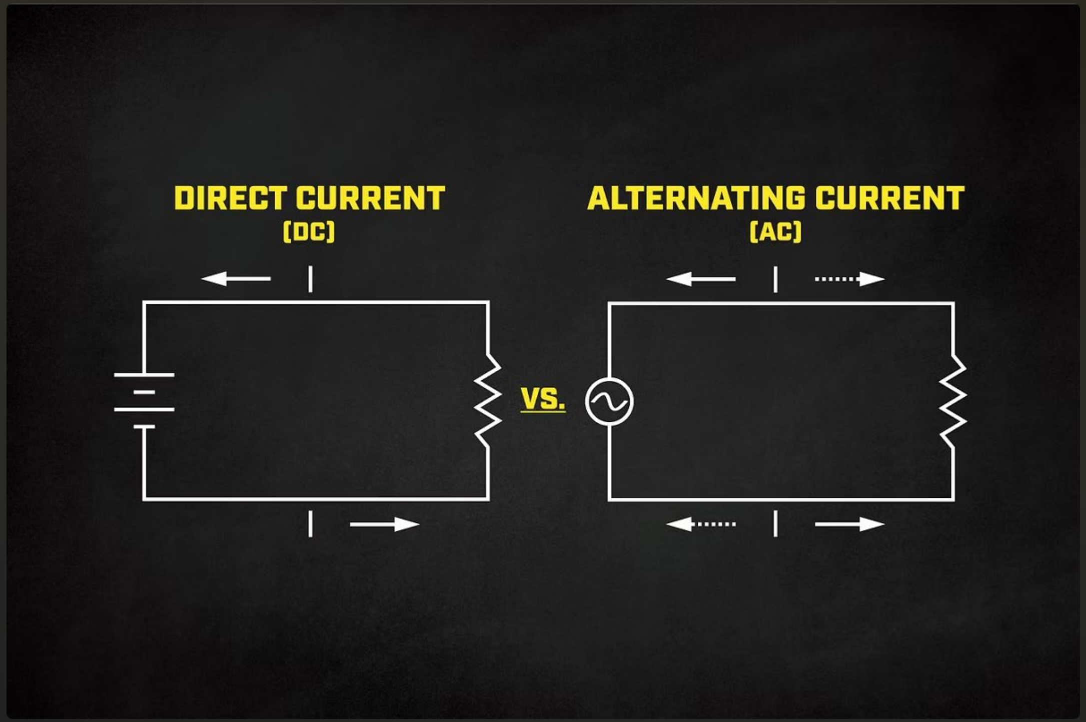
Objectives

Describe requirements for selecting and using power tools and accessories

Learn the key factors to consider when choosing the right power tool for your gas fitting tasks

Identify power tools and accessories

Recognize various power tools and their specific applications in gas technician work



Key Terminology

Term	Abbreviation	Definition
Alternating current	Ac or AC	An electric current that reverses its direction many times a second at regular intervals, typically used in power supplies.
Direct current	Dc or DC	An electric current flowing in one direction only.
Hydraulic power	-	When a liquid is used to generate power.
Pneumatic power	-	When compressed air (or other gas) is used to generate power
Powder-actuated tool	-	Nail gun used in construction and manufacturing to join materials to hard substrates such as steel and concrete
Revolutions per minute	rpm	Measure of the frequency of rotation, specifically the number of rotations around a fixed axis in one minute

Selecting Power Tools

Portable power tools provide the gas technician/fitter with speed and efficiency beyond that found with hand tools. However, their benefits are directly related to how you operate and maintain them.

Type of Work

Consider the specific task and which power tools are available for that application

Size Requirements

Determine the appropriate machine size needed for the job

Power Source

Ensure availability of appropriate power sources within the range of the machine's electrical connections

Safety Considerations

Always prioritize safety when selecting and operating power tools

Safety First

Follow Directions

Always operate power tools according to manufacturers' directions

Observe Regulations

Follow all necessary safety precautions (such as Workers' Compensation Board regulations)

Wear Protection

Always wear appropriate safety clothing and equipment as you work

Exercise Caution

Be extra careful when working in close quarters or up a ladder

Electric Power Tool Safety

Do

- Equip electrical power tools with a three-pronged grounding plug inserted into a properly grounded receptacle or double insulate them with a polarized plug and certified by CSA
- Clean the tools with an air hose to keep the motor and vents free from foreign matter to avoid overheating

Do Not

- Stand on wet surfaces while operating electric tools
- Touch water or metal piping when operating electric tools
- Overload the tool by forcing its operation with too large a work piece or when it is stuck
- Use too long extension cords
- Crimp the cord because continual flexing may break the wire or cause it to overheat
- Operate power tools in a gaseous or explosive atmosphere

Powder-Actuated Tools

Gas technicians/fitters use several powder-actuated tools to insert fasteners into concrete and steel.

Qualification Required

Do not use this equipment unless you are qualified and authorized to use the tool. You must hold a separate operator's card for each manufacturer's tools.

Proper Training

Each company that manufactures powder-actuated tools has designed a short course of instruction in the use of its tools. Only that course qualifies students for those tools.

Follow Regulations

Workers' Compensation Board regulations override any other instructions or precautions.

Powder-Actuated Tool Safety: Before You Start

Do

- Read the instructions and be sure that you understand them before you use the tool
- Operate the tool only if your supervisor authorizes you and if you are qualified with an operator's card
- Use only fasteners and powder loads manufactured for the tool you are using
- Always wear all required PPE and safety goggles rated for the task
- Store powder loads in a special container. Do not mix them with other objects or put them in your pockets
- Always check the material you are fastening into. Do not guess when the material is concealed

Do Not

- Use the tool in an explosive atmosphere
- Leave a tool untended where someone else might use it. Keep it locked up when you are not using it
- Attempt to fasten into glass block, tile, hardened steel, solid rock, slate, terra cotta, granite, glazed brick, cast iron, brick, hollow concrete block, marble, or unsound or cracked concrete

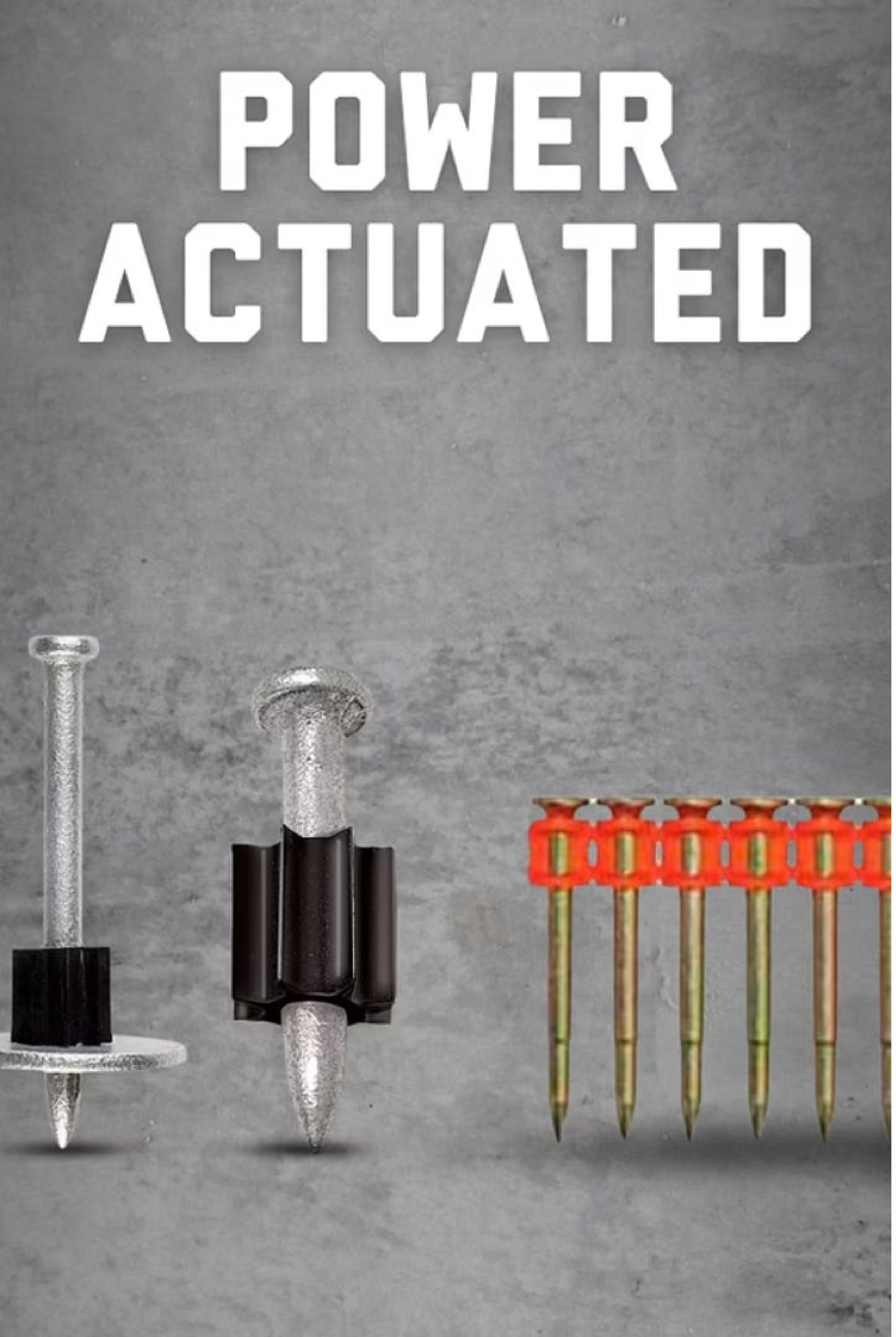
Powder-Actuated Tool Safety: As You Work

Do

- Stand behind the tool when firing it
- Keep the tool at right angles to the work surface
- Provide a backstop when firing into thin materials

Do Not

- Place your hands in front of the barrel
- Use more powder load than you need
- Point the tool at a person (including yourself). Keep other workers out of the line of fire



Minimum Material Requirements for Powder-Actuated Tools

65mm

Concrete Thickness

Minimum 2-1/2 inches of concrete required

5mm

Steel Thickness

Minimum 1/4 inch of steel required

50mm

Distance from Weld

Fasten at least 2 inches from a weld or vertical mortar joint

75mm

Edge Distance (Concrete)

Fasten at least 3 inches from the edge of concrete

Additional Powder-Actuated Tool Requirements

Edge Distance for Steel

Fasten at least 1/2 inch (12 mm) from the edge of steel

Failed Fastener Distance

Fasten at least 3 inches (75 mm) from where a former fastener failed

Special Adapter

Use a special adapter supplied by the tool manufacturer when driving a fastener into a hole

Storage

When you have finished, keep the unloaded tool and its cartridges in a dry locked container

Types of Power Tools

Cordless Tools

Battery-powered tools that provide mobility and flexibility

Corded Electric Tools

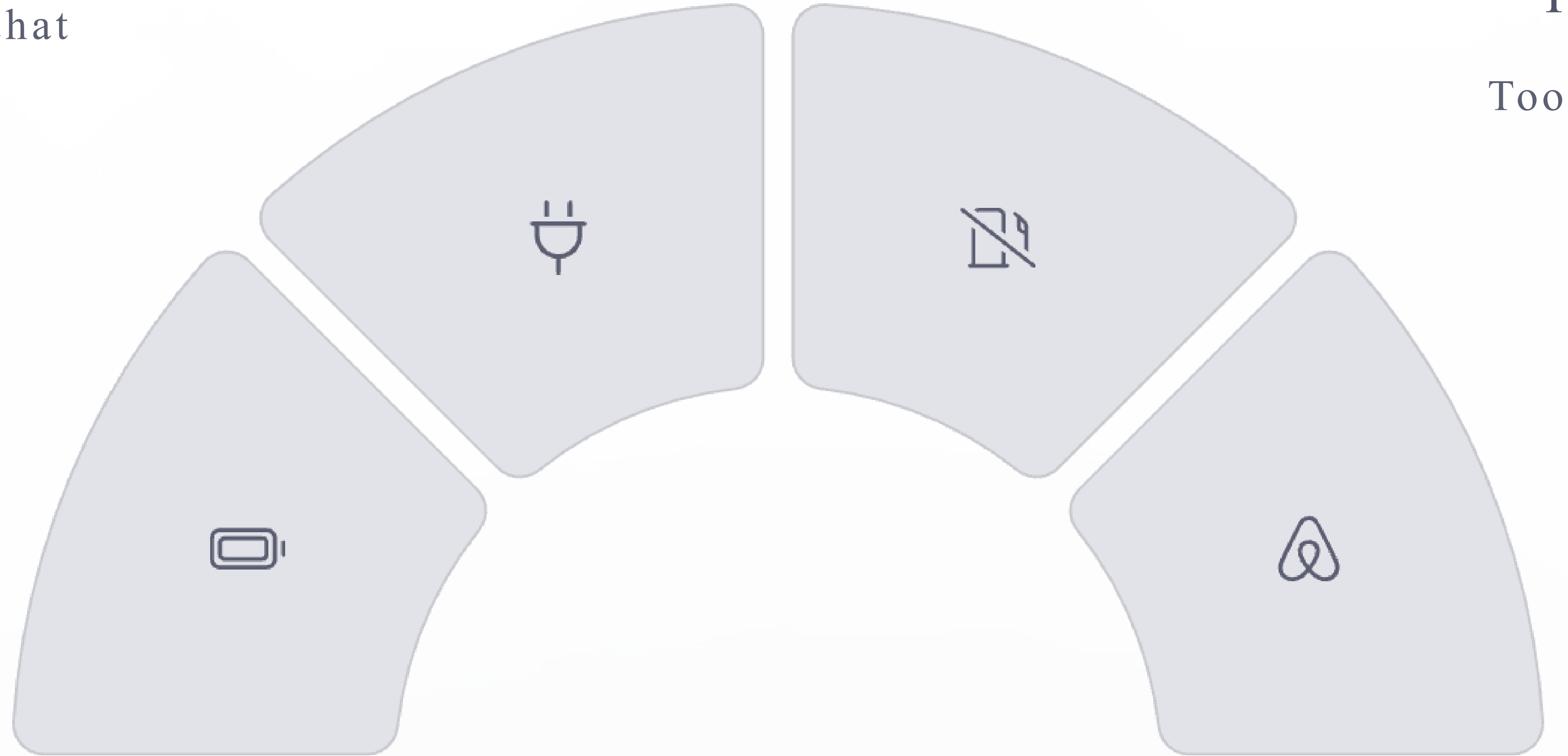
Tools that plug into an electrical receptacle

Gasoline-Powered Tools

Tools that use gasoline engines for power

Pneumatic Tools

Tools that use compressed air pressure



Cordless Tools

Most tools that gas technicians/fitters use are available in a cordless option for most applications. Cordless tools have many advantages. The most obvious advantage is the lack of an electrical cord for wider use and for applications where electric outlets are not available and where a risk of electrical shock exists.

Battery Care

You need to treat the battery as you would any 115- or 230-volt device, respecting all safety requirements and electrical codes.

Battery Designs

The batteries for cordless tools have many different designs, applications, and special safety requirements.

Manufacturer Instructions

Follow the manufacturer's instructions for charging, handling, and disposing of batteries for cordless tools.

Cordless drill and charger
Image courtesy of DeWalt

Cordless Drills

The most common cordless tool is the cordless drill shown in Figure 3-1.

Power Source

Some drills work on 110 V or 115 V alternating current (AC) and some are powered by rechargeable batteries that typically run on 18V direct current (DC).

Common Types

The three most common types of portable electric power drills used in the piping trades are:

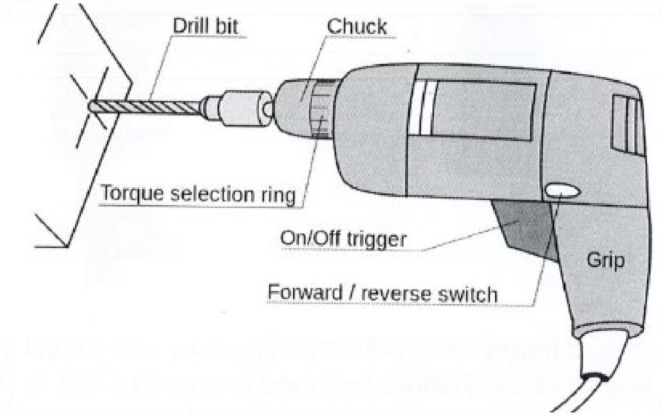
- 1/2 in (12 mm) portable drill
- 3/8 in (9 mm) portable drill
- Hammer drill

Size Reference

The sizes refer to the maximum size of drill shank that can fit into the chuck.

Standard Utility Drills

Figure 3-2 shows the familiar standard drill used for light work. Its chuck capacity ranges from 1/4 in to 3/8 in (6 mm to 9 mm) drill size. Some models have a reversing switch and speed control.



Standard Utility Electric Drill

Image Source: Wikipedia, Mikael Häggström from original by Kosiarz-PL

Applications

Used for light drilling work in various materials including wood, plastic, and thin metal

Compatible Bits

Works with a variety of bits designed for different materials and applications

Heavy-Duty Electric Drills

Figure 3-3 Heavy-duty electric drill

Specifications

The drills have chuck capacities ranging from 1/2 in to 3/4 in (12 mm to 19 mm). They usually have a reversing switch and a heavy-duty chuck.

Safety Precautions

You must exercise extra caution to avoid injury when operating these high torque drills due to the rotation. Protect your hands and wrist when operating this drill.

Compact Heavy-Duty Drills

Compact Design

Compact types of heavy-duty drills that you may use to drill through studs and joists

Power and Torque

These have power and torque to handle self-feed bits up to 4-3/4 in (120 mm) for wood and 1/2 in (12 mm) for steel

Control Features

They usually have speed control and a reversing switch

Right-Angle Drive Electric Drills

Figure 3-4
Right angle drive electric drill
Image courtesy of Milwaukee

Figure 3-4 shows a right angle drive electric drill

Applications

Helps drill through joists or studding, or in tight corners

Features

Some have speed control and a reversing switch

Advantages

The right-angle design allows access to spaces where a standard drill cannot fit, making it ideal for gas fitting work in confined spaces

Rotary Hammer Electric Drills

Figure 3-5 Rotary hammer drill

Purpose

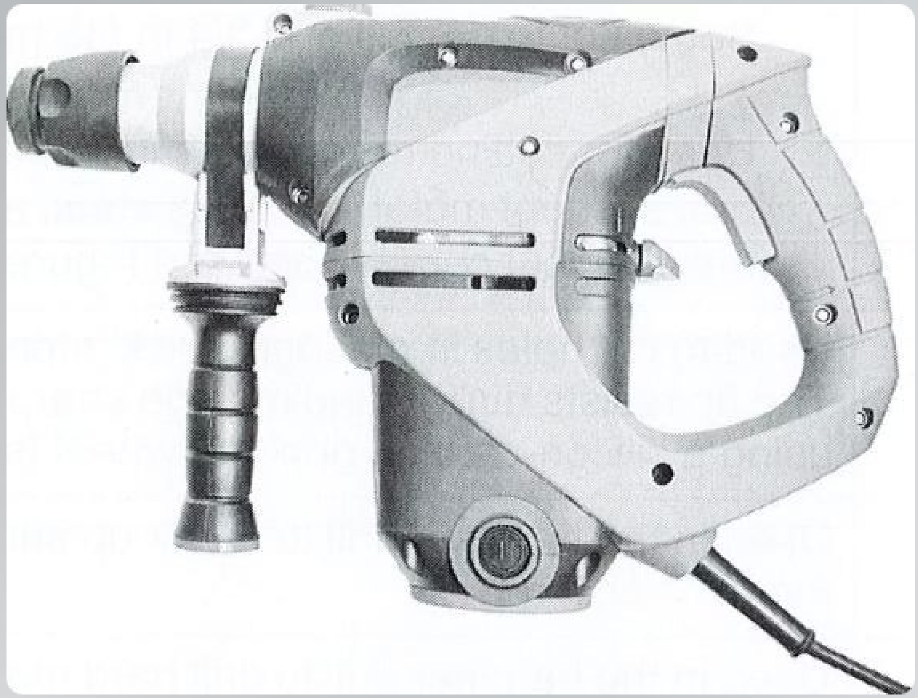
Gas technicians/fitters use rotary hammer drills for fast drilling in concrete.

Performance

Manufacturers claim it can drill 5.5 in (140 mm) per minute in construction-grade concrete with a 1/2 in (12 mm) bit.

Bits

These drills use carbide-tip bits.



How Rotary Hammer Drills Work

Dual Action

The hammer drill produces both a drilling action and a hammering action while drilling is taking place.

Combined Effect

The combined actions produce faster, more accurate work.

Power Sources

Many different hammer drills exist and there are three different energy sources that drive them: electric, pneumatic, or hydraulic drives—depending on the application.

Common Sizes for Hammer Drills

Drill Size	Hole Size
3/8 in (9 mm) drill	Up to 9/16 in (14 mm)
1/2 in (50 mm) rotary hammer	Up to 1 1/8 in (28 mm)
"Core" drill bit	Up to 2 in (50 mm) hole

Drill Accessories: Standard and Self-Feed Bits

Standard Carbon Drill Bit

The most common of all drill bits. Can be used to drill through steel (see Figure 3-6a).

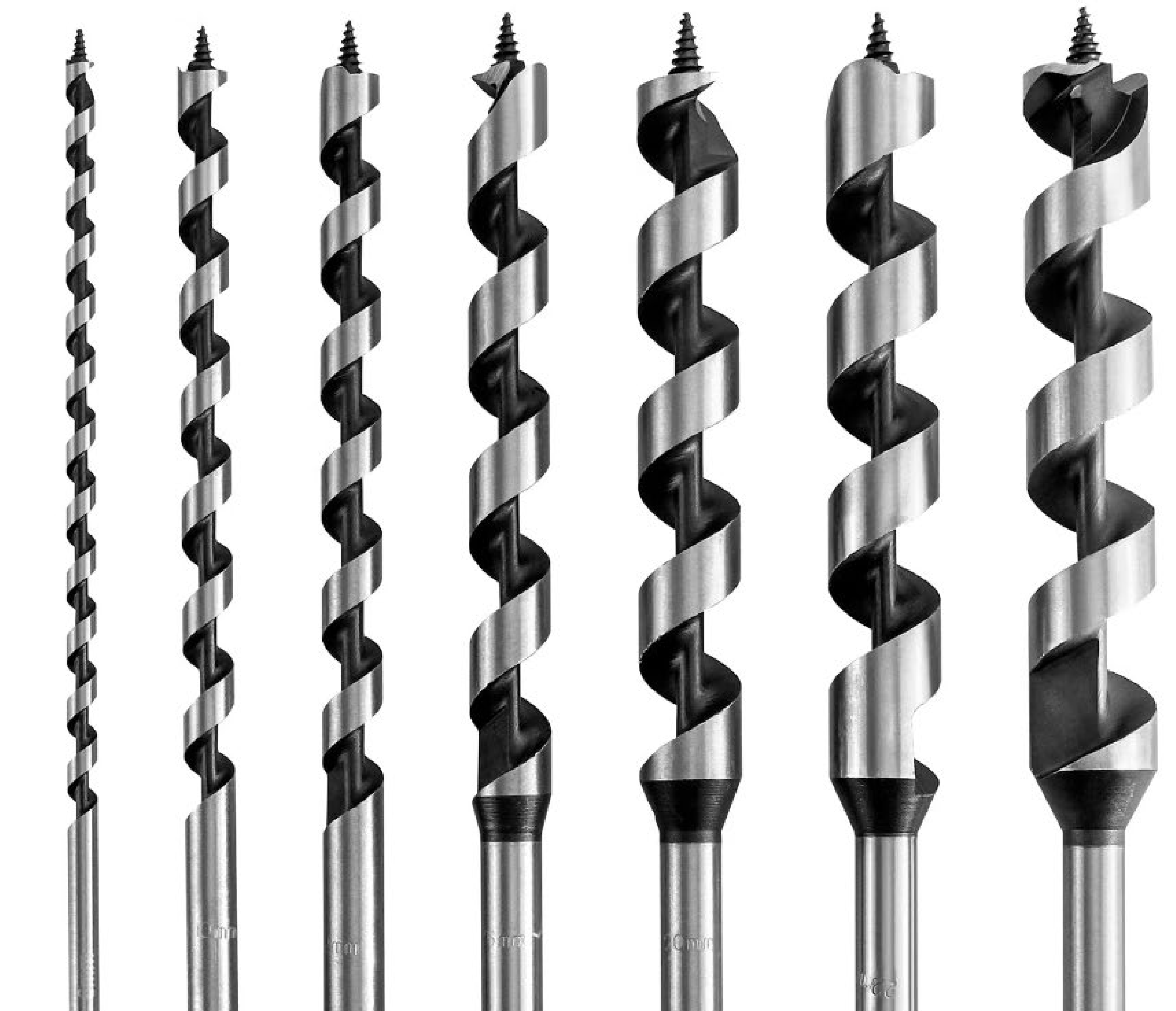
Self-Feed Bits

Used for cutting holes in wood for pipe sizes NPS 1/2 to 4. Some have replaceable feed-screw pilots (see Figure 3-6b).

Drill Accessories: Auger and Flat Boring Bits

Auger Bits

Available to drill holes for pipe sizes NPS 3/8 to 1 (see Figure 3-6c).



Flat Boring Bits

Have diameters from 1/4 in to 1-1/2 in. Used in small, pistol-grip electric drills (see Figure 3-6d).

Drill Accessories: High-Speed Hole Cutters

Cutting Depth

Some cut to depths of 1-3/4 in (45 mm)

Versatile Applications

Used for cutting round holes in wood, steel, aluminum, copper, brass, sheet metal, stainless steel, and plastics

Specialized Cutting

With carbide tips, they can cut ceramic tile (see Figure 3-6e)

Drill Accessories: Masonry Bits and Chisels

Carbide-Tip Masonry Bits

Used to cut holes in masonry brick, stone, plaster, slate, or concrete. The tip resists dulling and may be sharpened on a bench grinder using a silicon-carbide grinding wheel (see Figure 3-6f).

Chisels

Used in the hammer drill to break up such things as concrete tile (see Figure 3-6g).

Drill Accessories: Cruciform and Step Bits

Cruciform Drill Bits

Used in the hammer drill to drill hard materials such as marble and granite (see Figure 3-6h).

Step Bit

Used to drill holes of various sizes with a single bit. Particularly useful for sheet metal work (see Figure 3-6i).

Drilling Procedures: Inserting Bits

Disconnect Power

Disconnect the power cord before inserting or changing bits

Select and Prepare

Select a sharp drill bit and make sure the bit shank and chuck jaws are clean. Dirt may cause improper bit alignment.

Insert Properly

Open chuck jaws wide enough to allow bit to strike bottom of chuck. Tighten chuck jaws by hand first to align the bit, then use the chuck key progressively in all three holes to assure maximum chucking pressure.

Use Proper Tools

Do not use means other than the chuck key to tighten or loosen chuck jaws that require a key.

Drilling Procedures: Set-Up

Secure Material

Clamp material securely. When drilling into light gauge metal or wood, back up material with a wooden block to prevent bending and grabbing of material.

Mark Starting Point

Center-punch materials to be drilled to give the bit a start and prevent wandering.

Safety Check

Ensure all safety measures are in place before beginning the drilling operation.

Drill Operation: Getting Started

1 Motor Control

If drill has a reversing motor, allow the motor to stop completely before using the reversing switch.

2 Handle Installation

Install the auxiliary handle (if desired) into one of four positions on the drill for safer handling.

3 Lubrication

Lubricate the bit with cutting oil when drilling iron or steel. Lubricate with a water-soluble coolant (commonly soap and water) when drilling copper, brass, or aluminum.

4 Positioning

Hold drill on the centre mark of the hole to be drilled. Maintain a stable operating position and press the on-off switch to start the motor.

Drill Operation: During Drilling

Apply Pressure

Begin by applying steady pressure.

Break Chips

Stop from time to time to break up the chip.

Breakthrough Technique

When the drill is ready to break through the underside of material, decrease feed pressure so that the drill will not catch and break.

Hammer Drill Operation

Bit Installation

Place the drill bit in the chuck and tighten the chuck.

Depth Adjustment

Adjust the rod on the side of the tool to provide the required drilling depth. You reach this depth when the rod touches the concrete.

Power Check

Make sure that the supply voltage is the same as the voltage shown on the nameplate of the machine.

General Safety Rules: Before You Start

Do

- Wear protective clothing, particularly goggles or safety glasses. Remove loose clothing and jewelry. Tie long hair back or contain it in a net.
- Each type of power drill requires special attention. Read the instructions.
- If you are unsure of how to adjust or use the machine, ask for help.
- Ensure the work area is dry and well-lit.
- Bystanders should be clear of work area.
- Get help when lifting heavy vises or work pieces.
- Fasten the cutting tools properly in the chuck.

Do Not

- Because drilling can cause sparks, do not use drills where fumes or dust may cause combustion or explosions.

General Safety Rules: As You Work

Do

- Stop the feed from time to time when drilling to break up the chip so that it will not be a hazard and will be easier to handle.
- Use a brush instead of your hands to clean chips off the machine.
- Remove burrs from a drilled work piece as soon as possible, since any sharp edges or burrs can cause severe cuts. You can use a grinder or file for this purpose.

- When you finish using a drill or other cutting tool, wipe it clean with a shop towel and store it properly.

Do Not

- Use an air jet for removing chips unless a controlled air nozzle is used. An uncontrolled air nozzle will cause the chips to fly at a high velocity, with possible injury to the operator or bystanders.

General Safety Rules: Drilling Techniques

Pressure Control

When increasing the size of a hole with a larger drill, apply feed pressure slowly to prevent the drill bit from catching on work and breaking.

Breakthrough Technique

When drill is ready to break through underside of material, decrease feed pressure to prevent the drill from catching and breaking.

Power Management

Disconnect tools from the electric power supply when not in use before servicing and when changing parts.

Tool Maintenance

Lubrication

Lubricate gears and screws regularly according to manufacturer's recommendation

Cleaning

Keep tools clean and free of debris for optimal performance

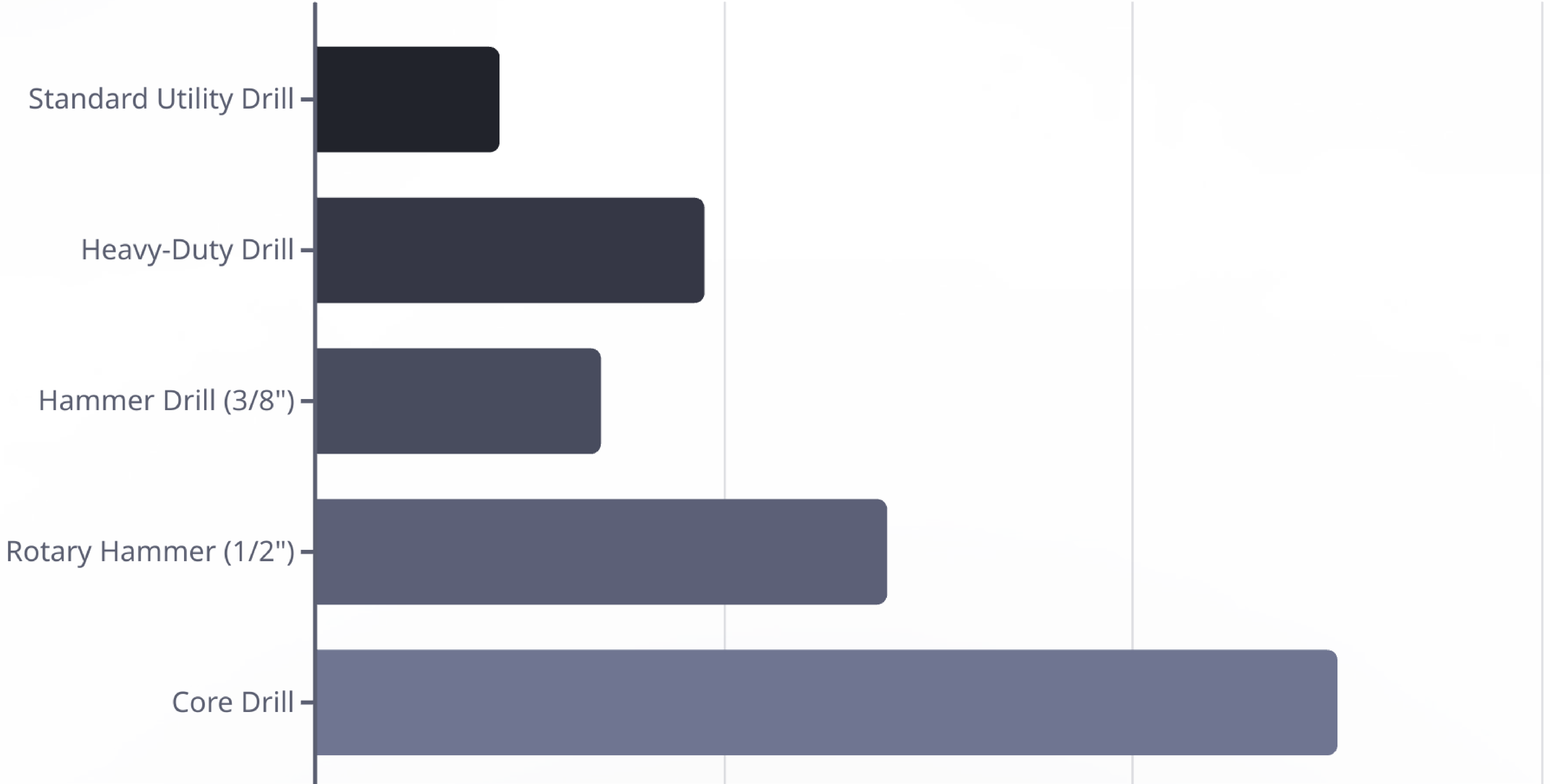
Inspection

Regularly check for wear and damage to ensure safe operation

Storage

Store tools properly in dry, secure locations when not in use

Selecting the Right Drill for the Job



Drill Bit Selection Guide

Wood Drilling

Auger bits, self-feed bits, flat boring bits

Metal Drilling

Standard carbon bits, high-speed hole cutters, step bits

Masonry Drilling

Carbide-tip masonry bits, cruciform bits

Demolition Work

Hammer drill chisels

Power Source Comparison

Battery Power (DC)

Portable, convenient, limited runtime

Electric Power (AC)

Consistent power, requires outlet, cord management

Pneumatic Power

Lightweight tools, requires air compressor

Hydraulic Power

High force capability, specialized applications

Safety Equipment for Power Tool Use

Eye Protection

Safety goggles or glasses protect eyes from flying debris, dust, and particles during drilling operations

Hand Protection

Work gloves provide grip and protect hands from cuts, abrasions, and vibration

Hearing Protection

Earplugs or earmuffs protect hearing from the loud noise produced by power tools

Respiratory Protection

Dust masks or respirators protect lungs from harmful dust and particles

Drill Speed and Material Guide

Material	Recommended Speed (RPM)	Lubrication
Soft Wood	1000-1500	None
Hard Wood	800-1000	None
Steel	300-800	Cutting oil
Aluminum	500-1000	Water-soluble coolant
Copper/Brass	400-800	Water-soluble coolant
Concrete	Hammer action	None

Common Drilling Problems and Solutions

Bit Wandering

Problem: Drill bit moves away from intended drilling point

Solution: Use center punch to mark starting point, apply steady pressure, start at low speed

Bit Binding

Problem: Drill bit gets stuck in material

Solution: Use proper speed for material, apply less pressure, clear chips frequently, use cutting lubricant

Overheating

Problem: Drill bit becomes too hot

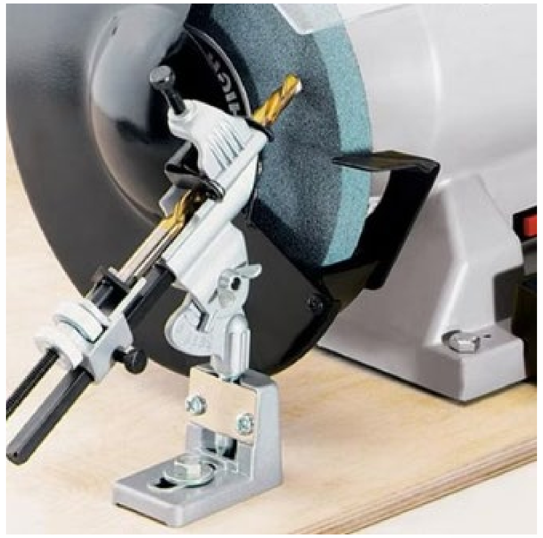
Solution: Use proper lubricant, reduce speed, take breaks to allow cooling, use sharp bits

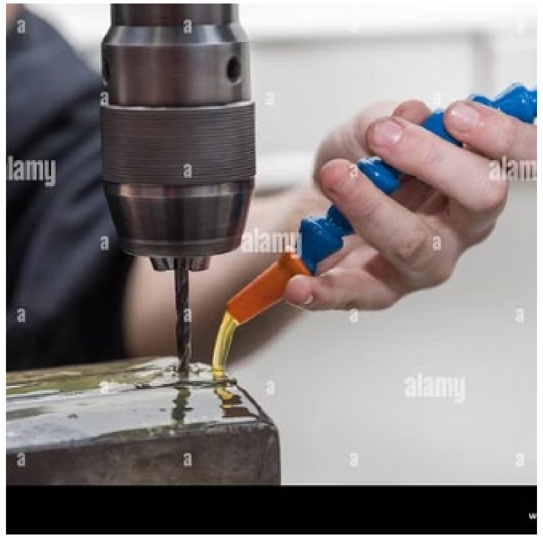
Rough Holes

Problem: Drilled holes have rough edges

Solution: Use sharp bits, proper speed, steady pressure, deburr after drilling

Drill Bit Maintenance





Proper maintenance of drill bits extends their life and ensures optimal performance. Regular cleaning, inspection for damage, proper sharpening, and correct storage are essential practices for gas technicians.

Specialized Drilling Applications for Gas Technicians

Pipe Penetrations

Creating holes for gas pipes through various building materials

Mounting Hardware

Installing brackets and supports for gas equipment

Ventilation Openings

Creating proper ventilation for gas appliances

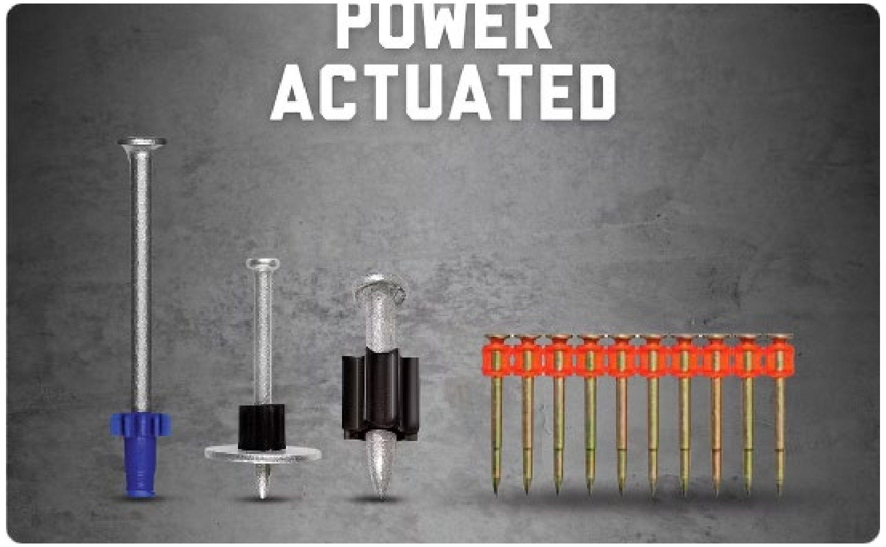
Meter Installations

Securing gas meters and related components

Powder-Actuated Tool Applications

Concrete Fastening

Securing gas line supports to concrete foundations and walls



Steel Fastening

Attaching brackets and hangers to steel structural elements

Fastener Types

Different fasteners for various applications in gas installation work

Key Takeaways

1

Safety First

Always prioritize safety when selecting and using power tools

2

Proper Selection

Choose the right tool and accessories for each specific task

3

Correct Technique

Follow proper procedures for tool operation and maintenance

4

Regular Maintenance

Keep tools clean and well-maintained for optimal performance and safety

Power Tool Safety Guide

This comprehensive guide covers essential safety practices for various power tools commonly used by gas technicians and fitters. From drills to saws, grinders to threaders, proper operation and maintenance of these tools is crucial for workplace safety and efficiency.

Portable Power Drill Safety

Secure Your Work

Use clamps, pliers or a vise-never use your hands to hold the work piece! This helps to avoid injury if the bit should bind during operation. It also frees both hands to operate the tool.

Disconnect Power

Disconnect power cord before inserting or removing bits.

Maintain Sharp Bits

Use sharp drill bits. Dull bits may damage gears or overload the motor.

Protect the Cord

Never use it to carry or disconnect the drill. Keep it from heat, oil, and sharp edges.

More Drill Safety Guidelines

Outdoor Work

When working outdoors, use only extension cords marked as suitable for outdoor use.

Proper Stance

Keep proper footing and balance at all times.

Remove Adjusting Tools

Remove adjusting keys and wrenches from tool before turning it on.

Motor Maintenance

Keep inlet and outlet air passage clear to ensure a cool running motor. Blow out accumulated dust from the motor frame with a regulated air jet.

Specialized Drill Operations

Reversing Switch Safety

If there is a reversing switch, make sure that motor is not running when switch is flipped. This avoids damaging the reversing mechanisms.

Right-Angle Drill Usage

If using a right-angle drill, remove the right-angle drive from the drill before removing the chuck from the drive.

Hammer Drill Operation

If using a hammer drill, make sure that the setting lever is not positioned while the drill is running.

Electric Saws Overview

Gas technicians/fitters often use electric saws of several different types. They allow for efficient, high-quality work. Removal of the burr, which is the sharp edge left by a saw, is recommended. Careful selection of saw type and blade can reduce burr to acceptable levels.

Efficient Cutting

Electric saws enable high-quality, efficient work for gas technicians.

Blade Selection

Proper blade choice reduces burrs to acceptable levels.

Burr Removal

Removing the sharp edge left by a saw is recommended for safety.

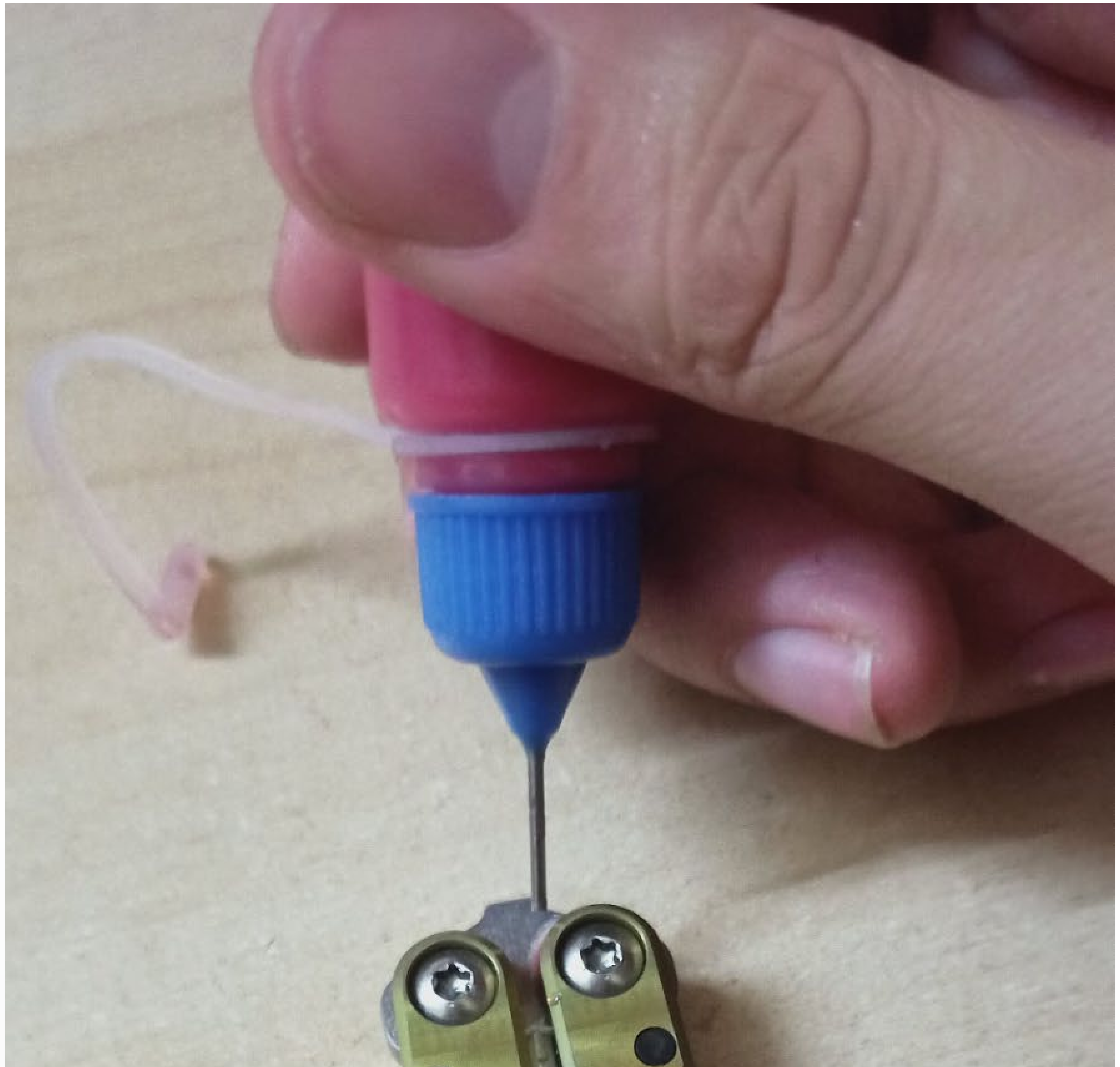
Cutting Rates and Lubrication

Proper Feed Rate

A feed that is too light overheats the wheel. Heavy feeding may cause the wheel to wear quickly or to break. Feed rates depend on the type of material to be cut, the type of wheel being used, the operating speed of the machine, and the condition of the abrasive sawing machine.

Anti-Welding Lubricants

For most cutting operations, gas technicians/fitters use anti-welding lubricants. This reduces friction between the cutting blade and the cut material as well as the chances of hirring or breaking the blade, giving a smoother, even cut.



Heavy-Duty Circular Saws

Gas technicians/fitters use this most familiar type of circular saw for making cuts along a marked line. They may help cut most shapes of plastic and non-ferrous metal stock such as pipe, tubing, and bars.

Mark Line

Clearly mark cutting line on material

Secure Material

Clamp work piece firmly in place

Cut Along Line

Guide saw carefully along marked line

Deburr Edges

Remove any sharp edges after cutting

Chop Saws

The chop saw is a large cutting tool often used to cut steel. You can place it flat on the floor, on a bench, or on a sawhorse. Individual and gang cutting tasks are both possible with a chop saw. Pay special attention to the personal protective equipment required for safe use of the different saw blades, and always wear a full face shield approved for the use.

Safety Equipment

Always wear a full face shield approved for use with chop saws.

Stable Placement

Place the chop saw on a floor, bench, or sawhorse for stability.

Versatile Cutting

Suitable for both individual and gang cutting tasks.

Chop-Saw Blades

Steel-Toothed Blades

Used to cut thermoplastics

Carbide-Tipped Blades

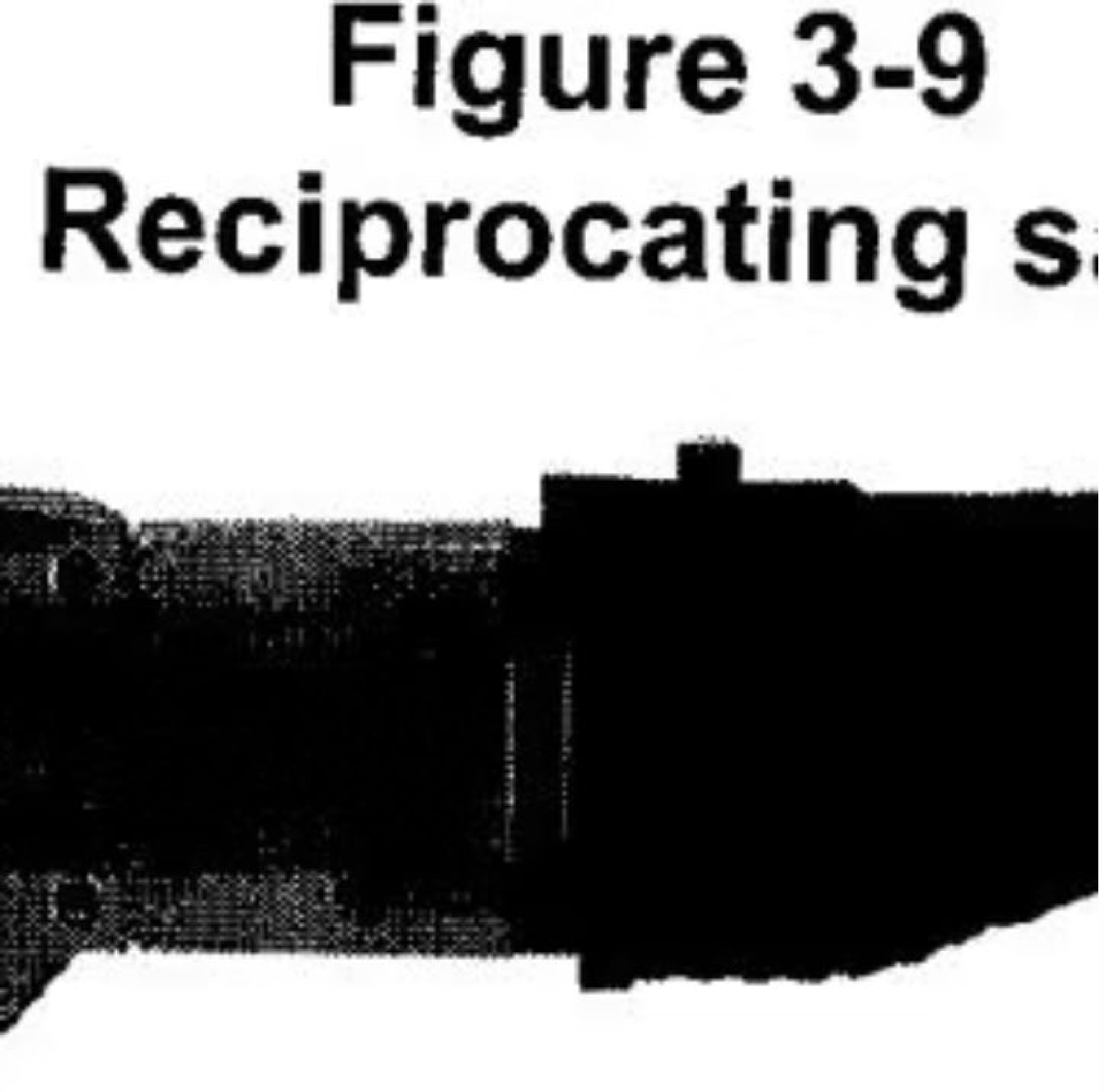
Used to cut non-ferrous metals and plastic

Grit Blades

Used to cut fibre-reinforced plastic

Abrasive Blades

Used to cut steel pipe or rod



Reciprocating Saws

Gas technicians/fitters widely use reciprocating saws, which are often called power hacksaws. They cut long pieces of pipe, wood, and laminates into lengths suitable for machining as well as pipe chases and oddly shaped holes in wood frame construction. They cut nearly any shape if you use the correct blade.

Pipe Cutting

Cuts long pieces of pipe into manageable lengths

Wood Cutting

Creates pipe chases and holes in wood framing

Versatile Shapes

Cuts nearly any shape with the correct blade

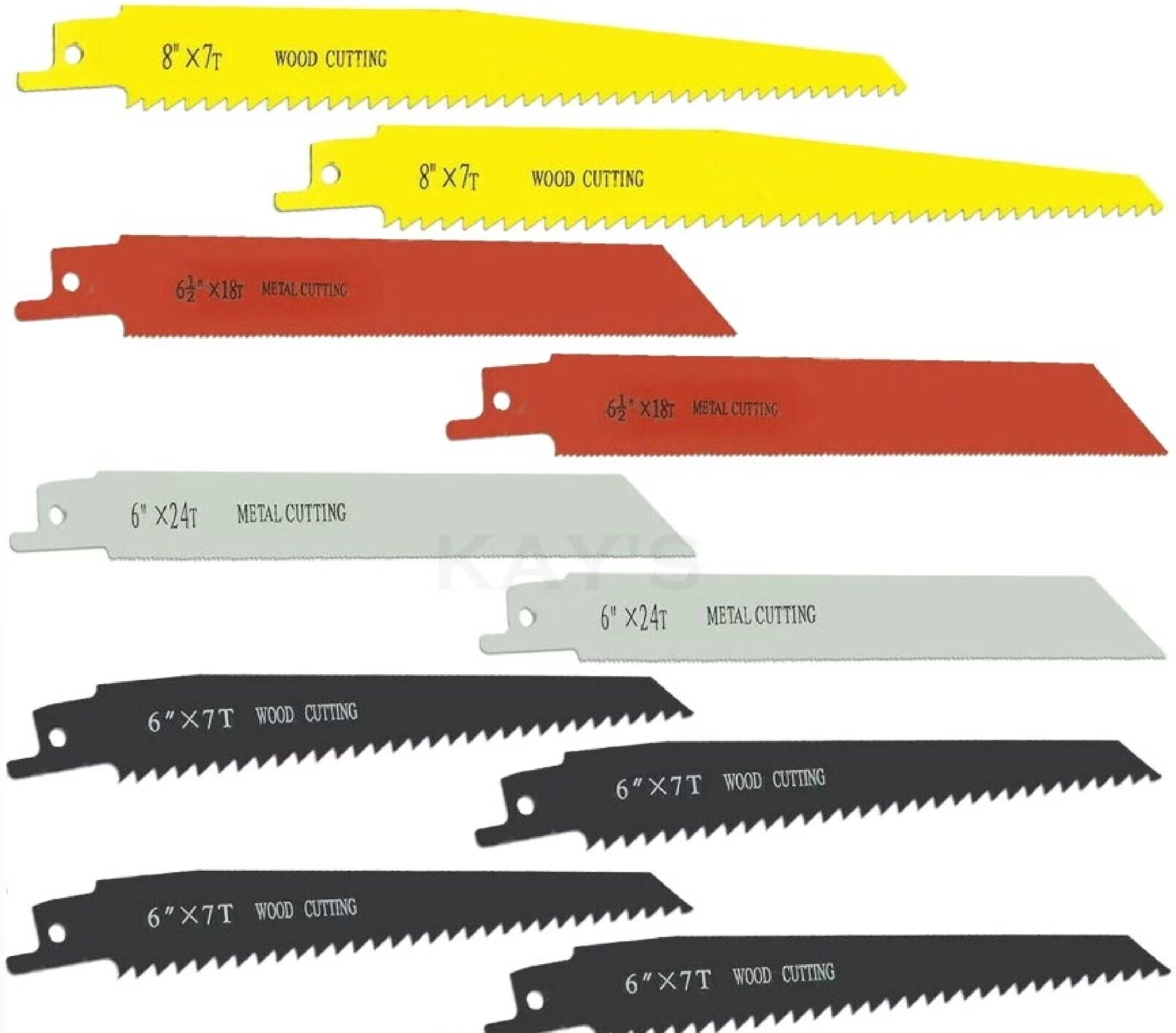
Saber Saw Blades

Blade Materials

Blades for these saws are made from carbide steel and high-speed alloy steel. They are color coded according to their use. For example, a blade for cutting stainless steel may be coded bright blue, while a general-purpose blade for cutting wood that may contain nails may be black.

Blade Selection

Be sure to check that you have the correct blade for the job. The blades come in various lengths, pitches (number of teeth per inch), tooth shapes, and tooth patterns (sets).



Heavy-Duty Electric Chain Saws

Use With Caution

You must use these saws with care. Aside from the hazards of any power tool with a cutting edge, there is a danger of kickback.

Protective Equipment

It is advisable to use a hard hat when using a chain saw.

Cutting Capability

This type of saw may easily cause flush cuts.

General Sawing Safety Procedures

Read the manual

Read the operator's manual carefully before using any saw

Locate controls

Identify ON/OFF switches or triggers before starting

Wear protection

Use safety footwear, hard hat, eye protection, and ear protection

Saw Selection and Preparation

Select Appropriate Saw

Select a saw that is suitable for the job at hand.

Inspect Cutting Edge

Use only recommended wheels or blades. Inspect the cutting edge of the wheel or blade for cracks, chips, and dullness. Discard if damaged.

Check Speed Settings

Make sure that the feed rate and speed of the machine are properly set.

Ensure Good Environment

Check that the environment is clean, dry, and well-lit.

Ventilation and Safety Precautions

Harmful Vapors

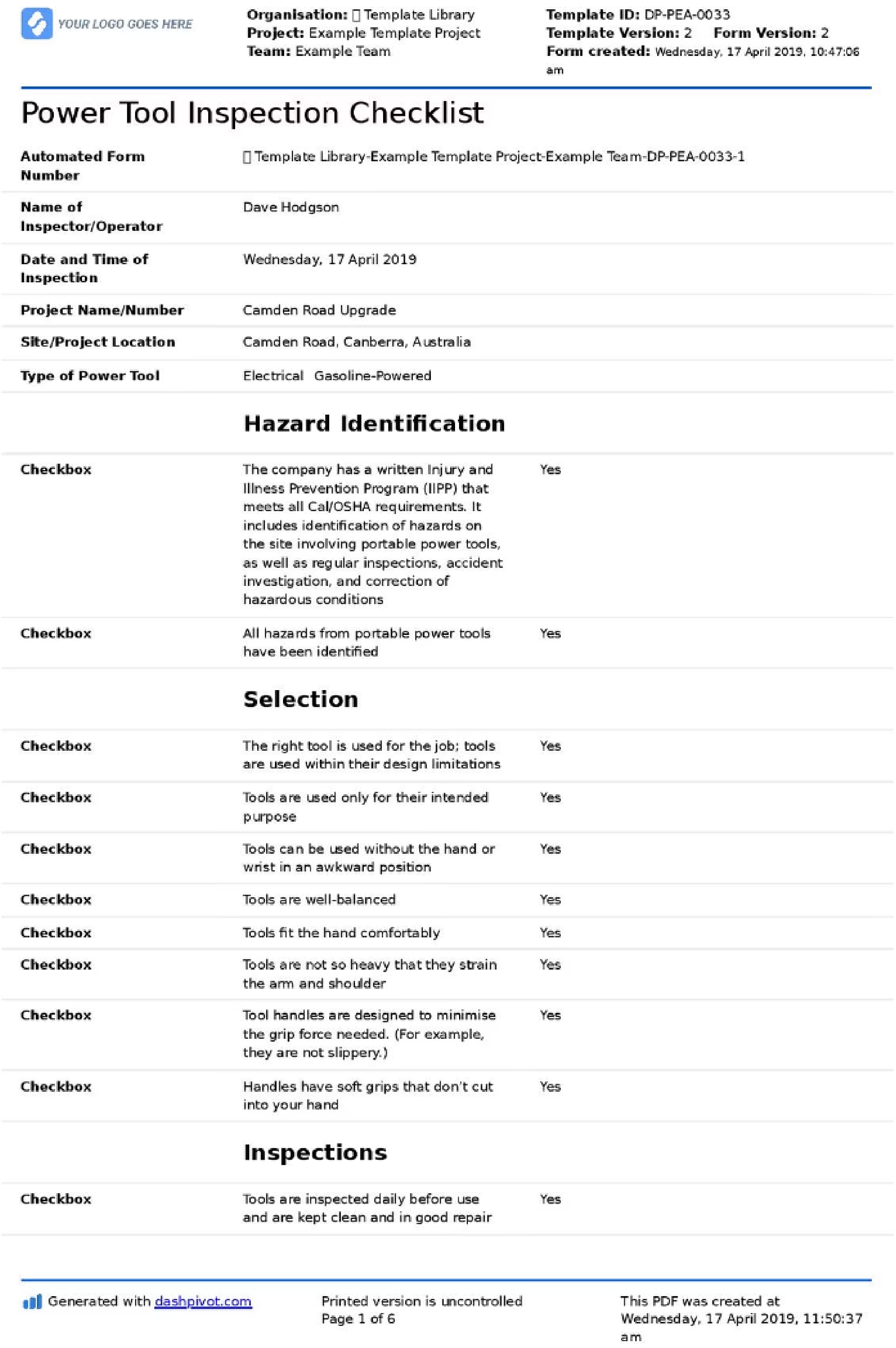
If you are to cut materials that give off harmful vapours, check that ventilation is adequate.

Metal Dust Hazards

When sawed, most metals give off dust and oxides that can be extremely hazardous to your health. If necessary, use a respirator.

Workspace Requirements

Allow enough space to operate the saw properly and allow others to pass safely. Keep bystanders a safe distance away from the work area.



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

Template ID: DP-PEA-0033
Template Version: 2 **Form Version:** 2
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Power Tool Inspection Checklist

Automated Form Number	Template Library-Example Template Project-Example Team-DP-PEA-0033-1	
Name of Inspector/Operator	Dave Hodgson	
Date and Time of Inspection	Wednesday, 17 April 2019	
Project Name/Number	Camden Road Upgrade	
Site/Project Location	Camden Road, Canberra, Australia	
Type of Power Tool	Electrical Gasoline-Powered	
	Hazard Identification	
Checkbox	The company has a written Injury and Illness Prevention Program (IIPP) that meets all Cal/OSHA requirements. It includes identification of hazards on the site involving portable power tools, as well as regular inspections, accident investigation, and correction of hazardous conditions	Yes
Checkbox	All hazards from portable power tools have been identified	Yes
	Selection	
Checkbox	The right tool is used for the job; tools are used within their design limitations	Yes
Checkbox	Tools are used only for their intended purpose	Yes
Checkbox	Tools can be used without the hand or wrist in an awkward position	Yes
Checkbox	Tools are well-balanced	Yes
Checkbox	Tools fit the hand comfortably	Yes
Checkbox	Tools are not so heavy that they strain the arm and shoulder	Yes
Checkbox	Tool handles are designed to minimise the grip force needed. (For example, they are not slippery.)	Yes
Checkbox	Handles have soft grips that don't cut into your hand	Yes
	Inspections	
Checkbox	Tools are inspected daily before use and are kept clean and in good repair	Yes

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Page 1 of 6
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Power Cord Safety

Regular Inspection

Check regularly that the power cord is in good condition. Replace or repair damaged cords using appropriately sized wire.

Protect From Damage

Keep the cord away from heat, oil, and sharp objects.

Outdoor Usage

When working outdoors, use only extension cords marked suitable for outdoor use.

Voltage Check

Before using saw, check to make sure the voltage agrees with the name plate rating.

Safe Work Practices During Sawing

Secure Work

Use clamps or a vise to hold the work piece, never your hands

Remove Tools

Take away adjusting keys and wrenches before turning on the saw

Handle With Care

Allow cut metal to cool before handling

Keep Clear

Keep hands away from all moving parts

Support and Electrical Safety

Support Heavy Materials

Use a pipe support or a similar support stand to hold long, heavy material while cutting. Ask for help when lifting or carrying heavy material.

Electrical Safety

When cutting into walls where electrical wiring may be concealed, use only the insulated switch handle and/or insulated auxiliary handle to control the operation of the saw.

Disconnect the power saw when changing accessories or to adjust, service, or move the saw.

What Not To Do When Sawing

Never Operate With Damaged Guards

Do not operate the saw with the guards raised, removed, cracked, or otherwise damaged.

Switch Position When Carrying

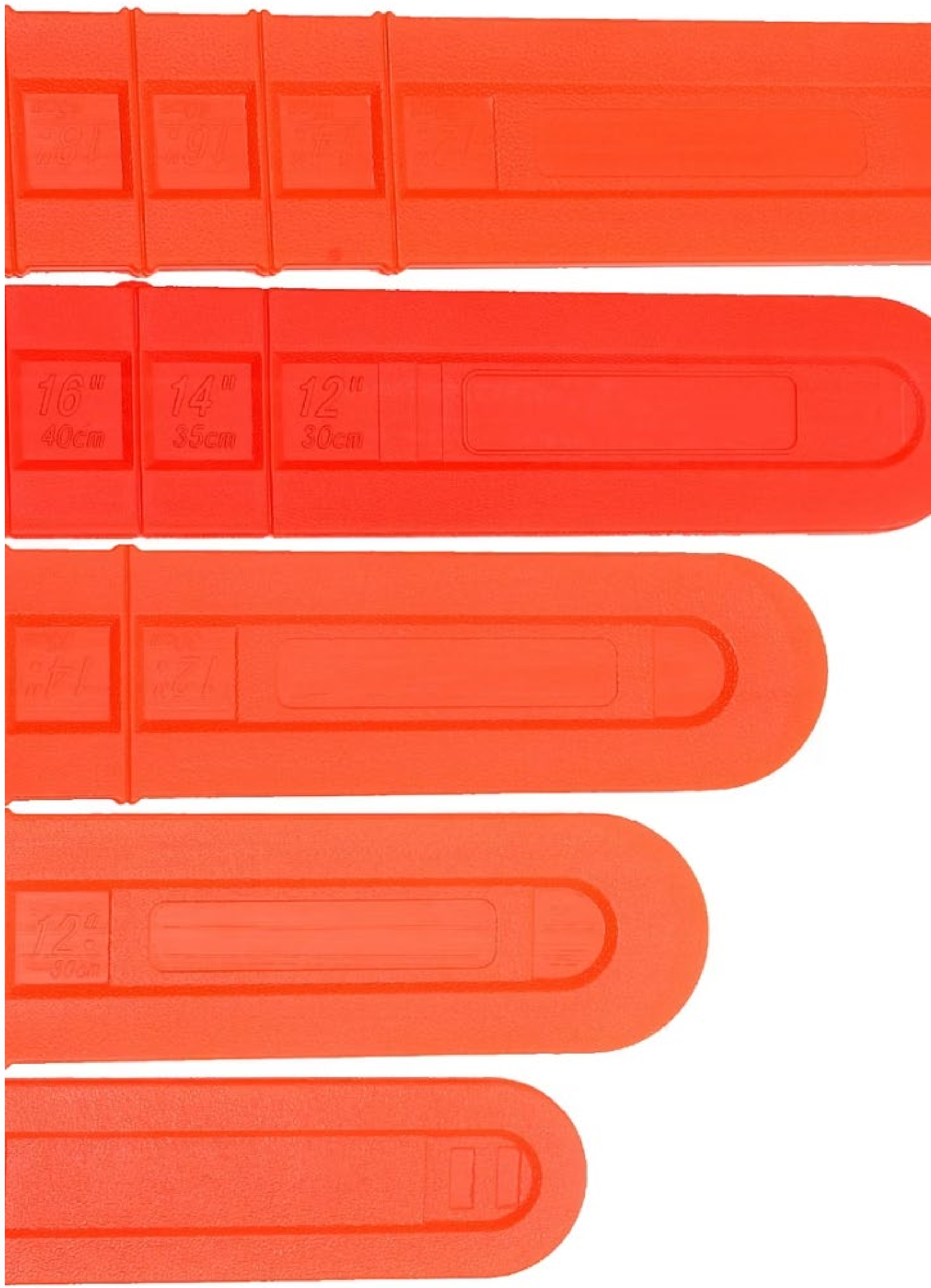
Do not carry a plugged-in tool with your finger on the switch. Be sure the switch is off when the tool is plugged in.

Maintain Balance

Do not overreach when sawing. Keep proper footing and balance at all times.

Avoid Forcing

Do not force the saw against the work material. The machine will operate more efficiently and safely at the rate for which it was designed.



Saw Maintenance

Clean Properly

Maintain the saw by replacing worn and broken parts and keeping the blades sharp and clean. Use a brush, not your hands, to clean the machine.

Use Identical Replacement Parts

When servicing all double-insulated tools, use only identical replacement parts.

Follow Lubrication Instructions

Follow instructions for lubricating and changing attachments.

Keep Work Area Clean

Keep your work area clean. Cluttered benches and slippery floors lead to accidents.

Chop Saw Blade Installation

Disconnect Power

Unplug saw power cord before changing or installing blade.

Access Blade Area

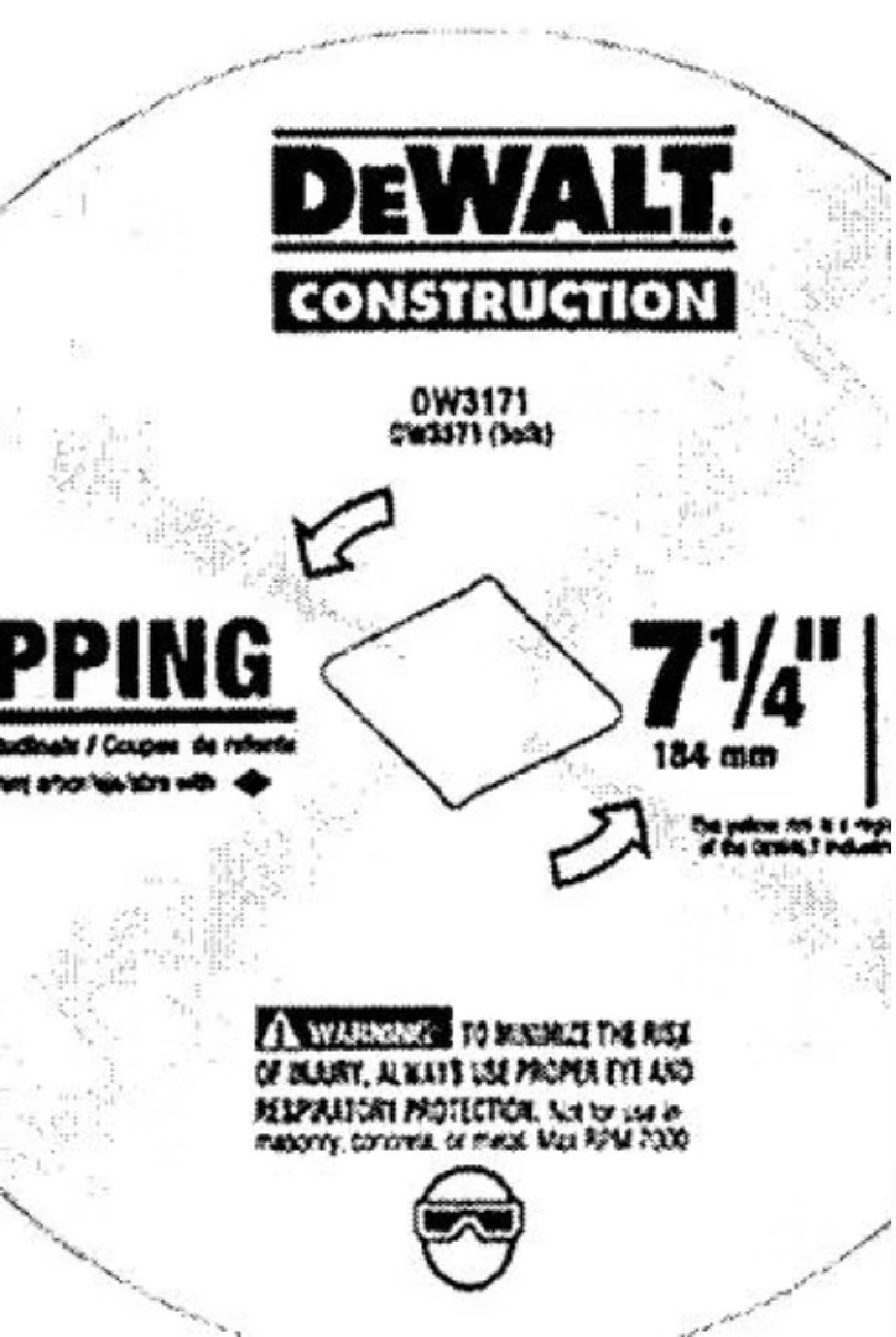
Raise the motor mount. Remove the hexagonal jam nut (left-hand thread), outer flange, and blade.

Inspect Components

Check blade flanges to be sure they are clean and free of burrs and nicks.

Install New Blade

Select the proper blade. Install the blade matching the arrows on blade and saw guard. Install the outer flange and hexagonal jam nut.



Chop Saw Pre-Operation Checks

Check Drive Belt

Check the condition and tension of the drive belt.

Verify Blade Direction

Check that the direction/orientation of the saw blade is correct. Saw blades are normally installed with the teeth pointing in the direction of the cut.

Test Guards

Manually raise and lower saw blade guards to assure free movement.

Inspect Power Cord

Check the power cord. The power cord is short in order to prevent possible contact with the blade. Supplying power requires the use of a grounded extension cord and receptacle.

Operating the Chop Saw

Prepare the Saw

Disengage lock holder from motor mount.

Secure the Material

Raise saw blade and clamp material firmly in vise jaw. Make sure that long pieces are properly supported.

Make the Cut

Press the switch and feed the blade through work piece. The desired pressure occurs just before the machine speed starts to slow down.

Handle Overheating

If the motor trips out from overheating, allow the motor to cool before pressing reset button. A thermal overload protector protects the saw motor from overheating and damage.

Finishing Chop Saw Operations

Aluminum Cutting

When cutting aluminum, apply a solid or liquid lubricant to the blade after every few cuts.

Removing Material

Loosen vise jaw and remove the material.

Powering Down

Unplug power cord when finished with the operation.

Chop Saw Maintenance

You must inspect drive belt tension regularly. A low belt tension results in belt slippage and immediate damage to the belt. If there are signs of wear, replace the belt.

Regular Inspection

Check belt tension frequently

Prevent Slippage

Low tension causes damaging belt slip

Replace When Worn

Change belt at first signs of wear

Reciprocating Saw Blade Selection

Choose Proper Blade

Select the proper blade for material to be cut.

Insert Blade

Insert the blade into front end of saw by loosening the appropriate screw with a blade wrench.

Secure Blade

Insert blade and tighten screw. Make sure that the blade is held tightly.

Safety First

When changing blades, disconnect the power cord.

Reciprocating Saw Speed Selection

OFF Position

Full release of trigger.

LOW (LO) Speed

Partial depression of trigger.

HIGH (HI) Speed

Full depression of trigger.

Lock Feature

You may lock the trigger in the high or low position using the lock button.

Power Grinders Overview

Gas technicians/fitters must often fabricate brackets, stands, supports, and hangers while installing equipment. They use power grinders to do this.

Creating Cutting Edges

A power grinder helps make cutting edges on cutting tools.

Shaping Metal

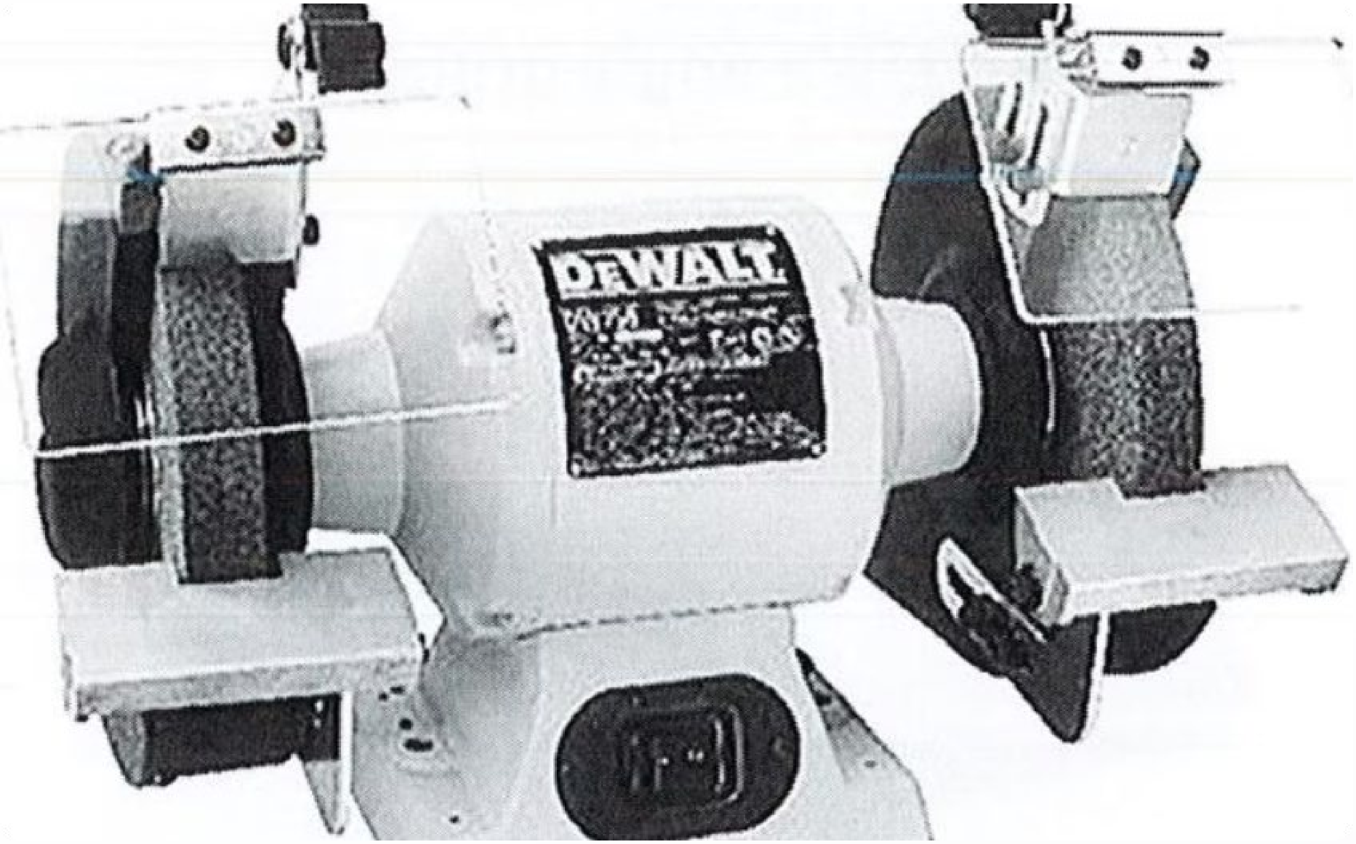
Cut metal to its desired shape and size.

Surface Finishing

Make smooth, polished surfaces.

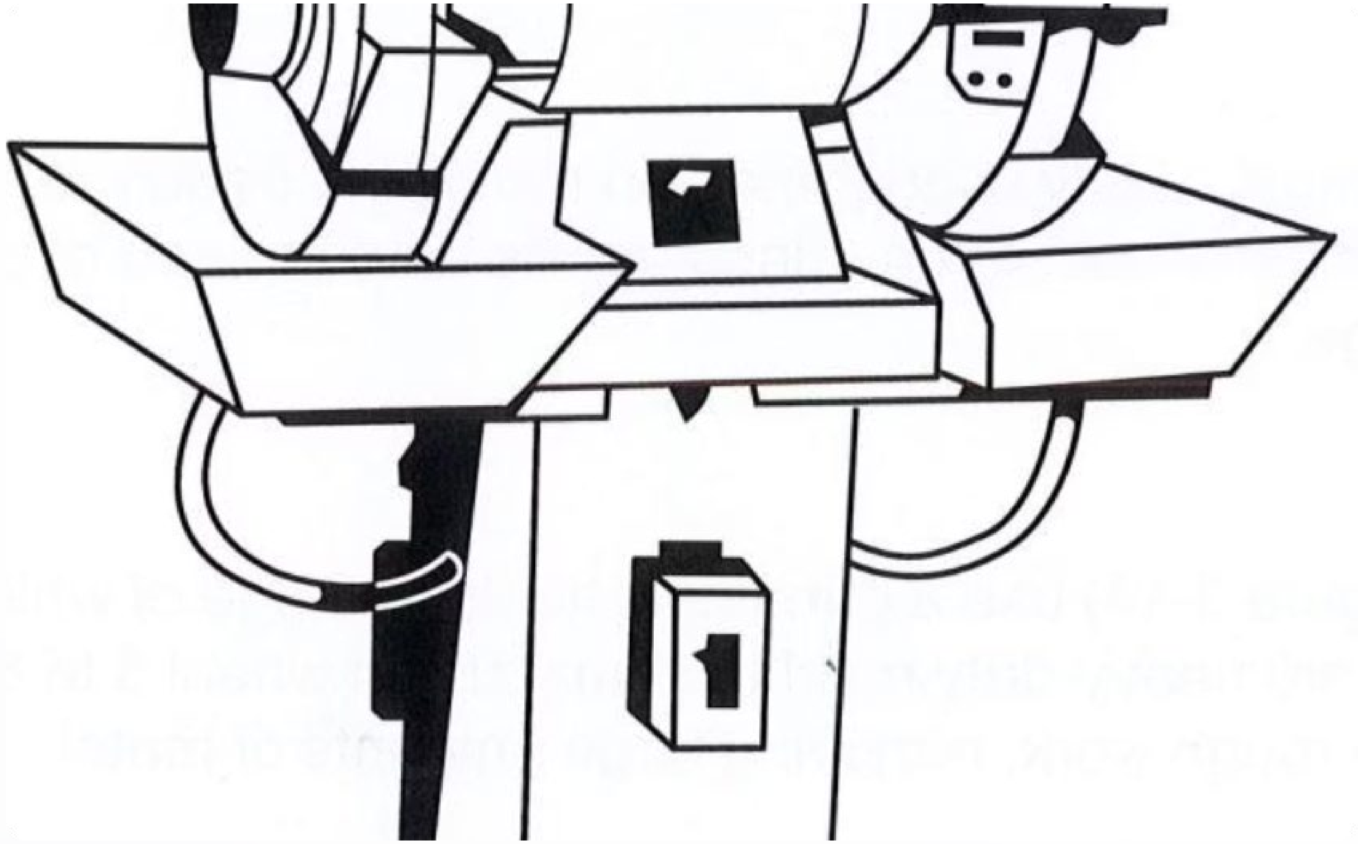
Stationary Grinders

The two most common types of stationary power grinders used in the piping trades are the bench and pedestal grinders. These grinders are used to do off-hand grinding, that is, grinding that does not demand great accuracy of size or shape. The work is held in the hands and ground to the desired shape.



Bench Grinder

Mounted on workbench for convenient access



Pedestal Grinder

Floor-standing model with its own base

Portable Grinders Introduction

Gas technicians/fitters use portable power grinders when the work is too large or awkward to be held comfortably at a bench or pedestal grinder. Portable grinders are more practical than stationary grinders because they are light enough to be carried to the job and you can hold it by hand while grinding.

Power Sources

Either electricity or air powers portable grinders. Both electrically operated and air-operated (pneumatic) grinders are available in light and heavy-duty models.

Grinder Selection

The selection of a grinder depends on the type of power outlet available, the type of job to be performed, and the dampness of the work area.

Angle Grinders

The angle grinder is the most widely used grinder in the piping trades. It cleans and smooths metal surfaces. Angle grinders most often grinds bevels onto the end of pipes or cleans weld spatter off pipe and fittings.

Pipe Beveling

Creates beveled edges on pipe ends

Surface Cleaning

Removes weld spatter from pipes and fittings

Metal Smoothing

Creates smooth finished surfaces on metal

Straight Grinders

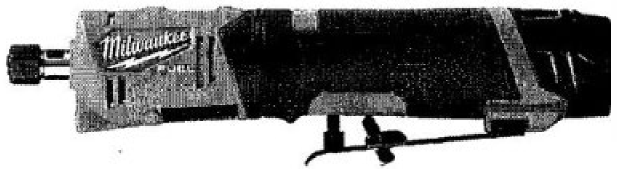
Heavy-Duty Straight Grinders

Straight grinders use a grinding wheel, the edge of which is used as the abrasive surface. These are heavy-duty machines that use a wheel 5 to 6 inches (125 to 150 mm) in diameter for fairly rough work, removing large amounts of metal.

Figure 3-14
Pneumatic straight grinder
Images courtesy of Milwaukee

Pencil Grinders

The pencil grinder is a light-duty straight grinder. Gas technicians/fitters use this for delicate work such as deburring holes, die finishing, removing slag from the insides of pipes, and trimming weld overlaps.



Grinder Abrasives

Crushing and grinding hard, tough materials make abrasives, which have many sharp cutting edges and points. Abrasives must be harder than the materials they cut.

Coated Abrasives

Gas technicians/fitters use these with portable and stationary grinders, usually for finishing. The two forms are disks-often called sanding disks-and belts.

Mounted Grinding Wheels

Has a small stone point or wheel permanently attached to a shaft. It is used on small portable grinders and electric drills.

Regular Grinding Wheels

Used with portable and stationary grinders.

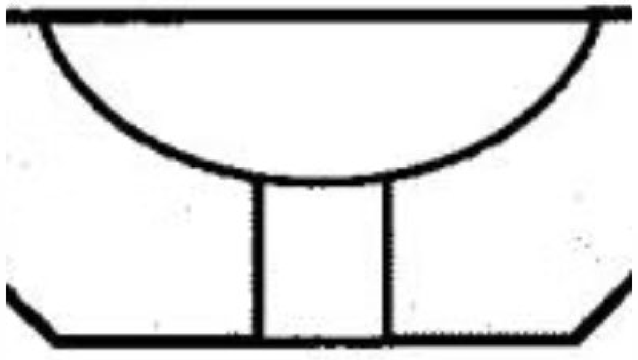
Disk Grinding Wheels

Thinner than regular wheels or stones. Has a wire backing that strengthens the disk so that it can stand up to the rough use it receives grinding with the side surface rather than the edge.

Grinding Disks

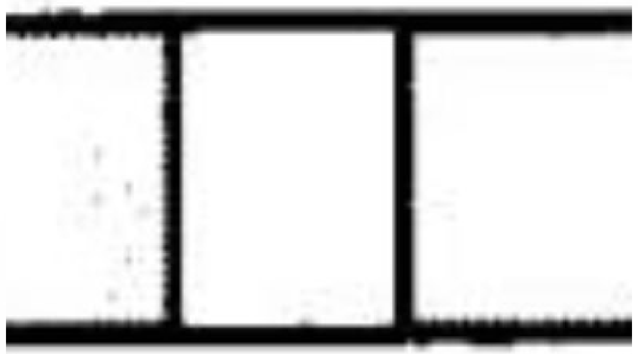
Types of Grinding Disks

The two kinds of grinding disks are the flat disk and the depressed centre disk. The most common, the depressed centre disk, has its central area depressed so that the spindle nut is less likely to touch the work.



Flat Disk

Used for surface grinding applications



Depressed Center Disk

Allows spindle nut clearance from work surface

Grinding Wheel Selection Factors

Wheel Shape

Consider the shape of wheel needed for the application.

Wheel Face Type

Select the appropriate type of wheel face for the job.

Wheel Dimensions

Consider the diameter and thickness of wheel needed.

Hole Size

Ensure the diameter of wheel hole matches your machine.

Speed Rating

Check that the manufacturer's maximum speed rating for the wheel is higher than the machine's RPM.

Material Compatibility

Select a wheel appropriate for the type of material to be ground.

Grinding Wheel Holes

The hole in a grinding wheel should be 0.02 in (0.5 mm) larger than the diameter of the shaft on which it is mounted. This allows it to slide freely but not loosely on the shaft.

0.02 in

Clearance

Ideal clearance between wheel hole and shaft

0.5 mm

Metric Equivalent

Same clearance in millimeters

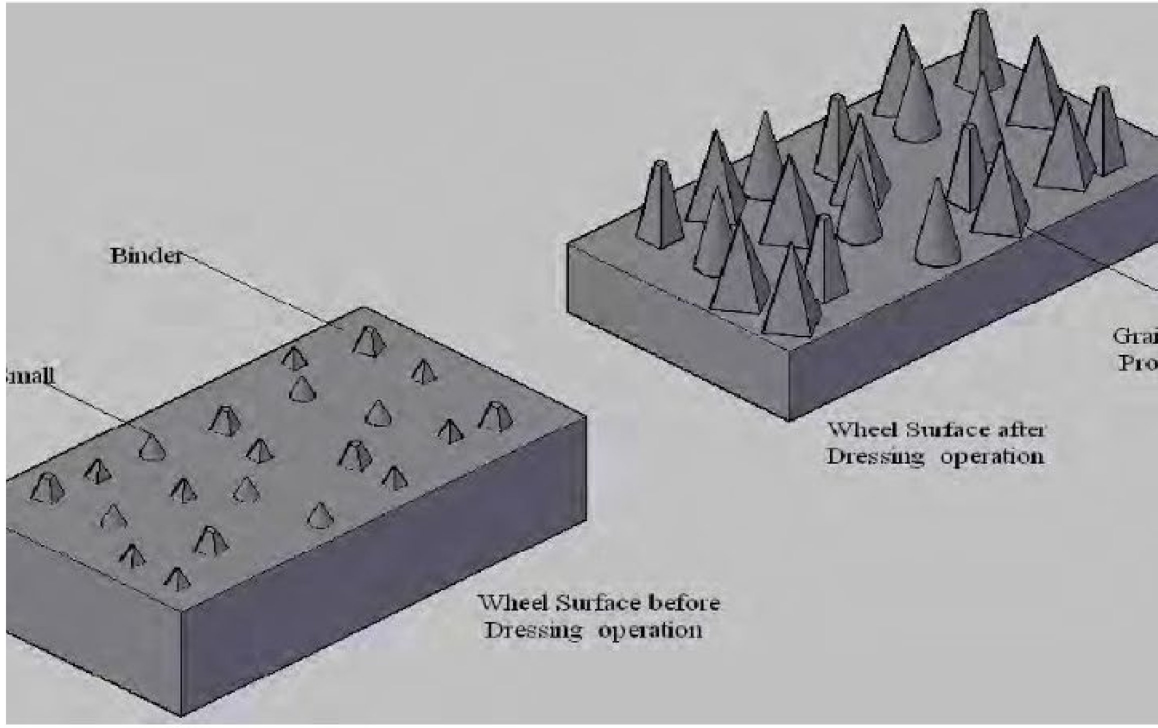
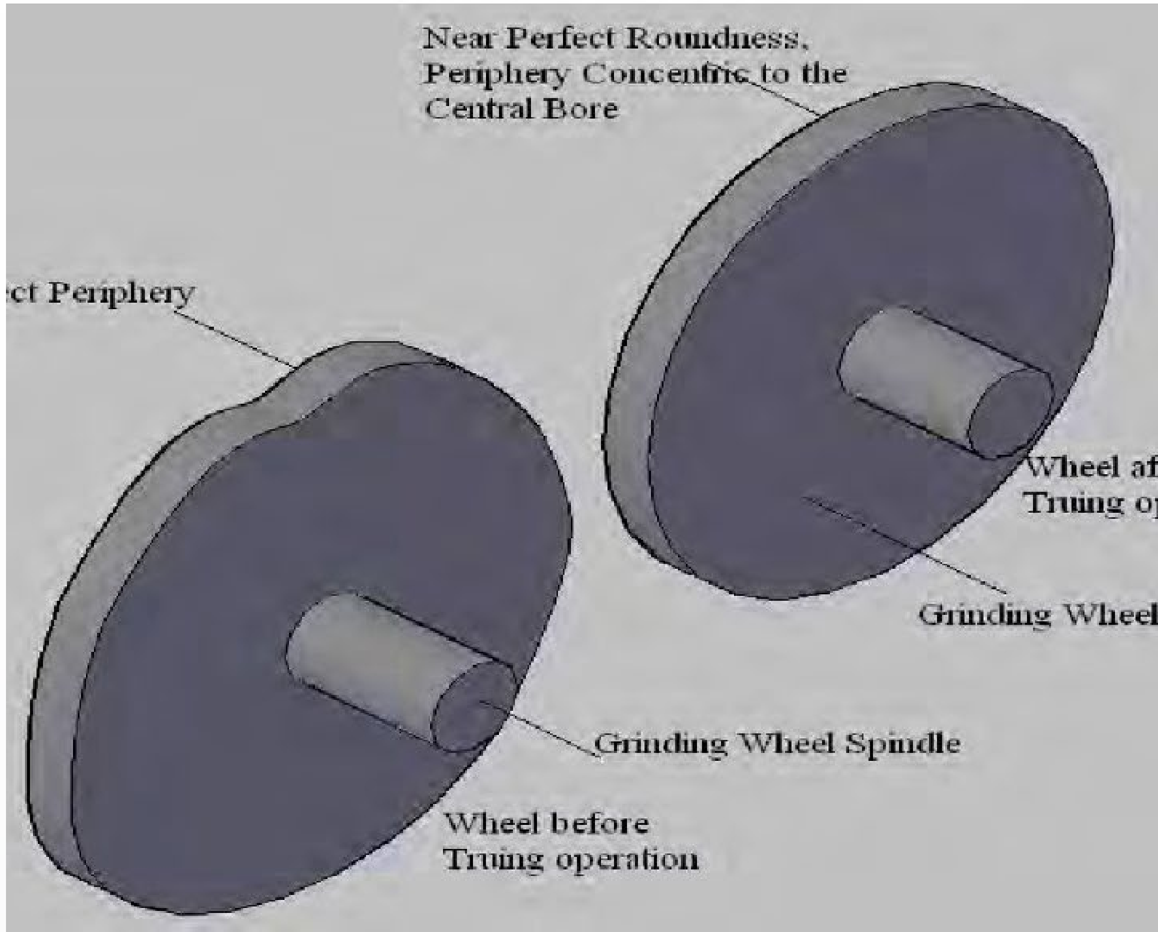


Fig. 1. Principle of dressing operation.



Grinding Safety: Protective Equipment

Proper Clothing

Wear snug-fitting coveralls to prevent loose fabric from getting caught

Eye Protection

Always wear goggles to protect eyes from flying particles

Hearing Protection

Use ear plugs to protect against loud grinding noise

Safety Footwear

Wear safety boots to protect feet from falling objects

Hand Protection

Use appropriate gloves to protect hands from sparks and debris

Grinding Pre-Operation Checks

Power Off During Setup

Always ensure that the grinder is off before mounting a new wheel.

Wheel Inspection

Before turning the grinder on, check the wheel for defects (cracks, chips, etc.), make sure that the wheel surface is sharp, and check that the sides are straight.

Proper Lubrication

Lubricate parts of the grinder according to the manufacturer's specifications.

Correct Wheel Selection

Choose the correct wheel. Grind soft materials such as copper, brass, lead, or aluminum with wheels made for that use.

Good Lighting

Work in a well-lit area.

Safe Grinding Practices

Stand Safely

Stand to the side of a stationary machine when it is first turned on until operating speed is reached. As you work, stand away from the discarded material.

Maintain Guards

Keep machine guards, work rests, and safety shields in position and tightened.

Clear Before Starting

Make sure that the material is clear of the wheel before starting the machine.

Control Speed

Maintain a grinding wheel speed below the maximum revolutions per minute specified by the manufacturer.

Proper Work Handling During Grinding

Secure Grip

Hold work tightly at all times. Use a vise grip if the work is too small to hold safely by hand. Do not use pliers.

Prevent Grooving

Move the work back and forth across the face of the wheel to avoid grooving of the wheel.

Hand Placement

Keep hands away from the spinning grinding wheel.

Damaged Wheels

If you damage a wheel, remove it, even if it does not appear to be cracked or broken.

Stationary Grinder Procedure

Select Appropriate Wheel

Choose a wheel with proper RPM rating, hole size, and material compatibility. Check for cracks by tapping lightly (a clear ring indicates no cracks).

Mount the Wheel

With power off, mount the wheel onto the shaft with safety washers between wheel and collars. Tighten nut firmly but don't over-tighten.

Test Run

Lower the guard, stand to one side, and turn on power. Let wheel run at full speed for at least one minute, then turn off.

Adjust Tool Rest

Set the tool rest with clearance of no more than 1/16 inch from the wheel.

Portable Grinder Operation

Select Grinder

Choose appropriate electric or pneumatic grinder for the job

Inspect Equipment

Check wheel for defects and secure safety guards

Secure Work

If work piece is small, secure it with vise or C-clamp

Operate Safely

Turn on machine, apply even pressure, direct debris away from you

Additional Portable Grinder Safety

Avoid Slot Grinding

Never grind in a slot with a portable grinder.

Corner and Edge Work

When grinding, sanding, or wire brushing into corners or on edges of material, ensure that the machine is not wrenched from your hands.

Electric Grinder Safety

Make sure that the power cord is in good condition and perform work in a dry location.

Pneumatic Grinder Safety

Ensure proper air pressure, adequate oil supply, and good condition of air hose.

Powder-Actuated Tools

Every manufacturer's tool is slightly different, and you must study each separately before use. Study the manufacturer's specifications when deciding the type, size, and charge for use in a situation. Note the general safety instructions given in Unit 1 Safety.

Misfire Procedures

It is very important to know the procedure for misfire. Read the manufacturer's instructions.

Speed Measurement

The speeds given are measured 2 m (6 ft) in front of the tool.

Safety Resources

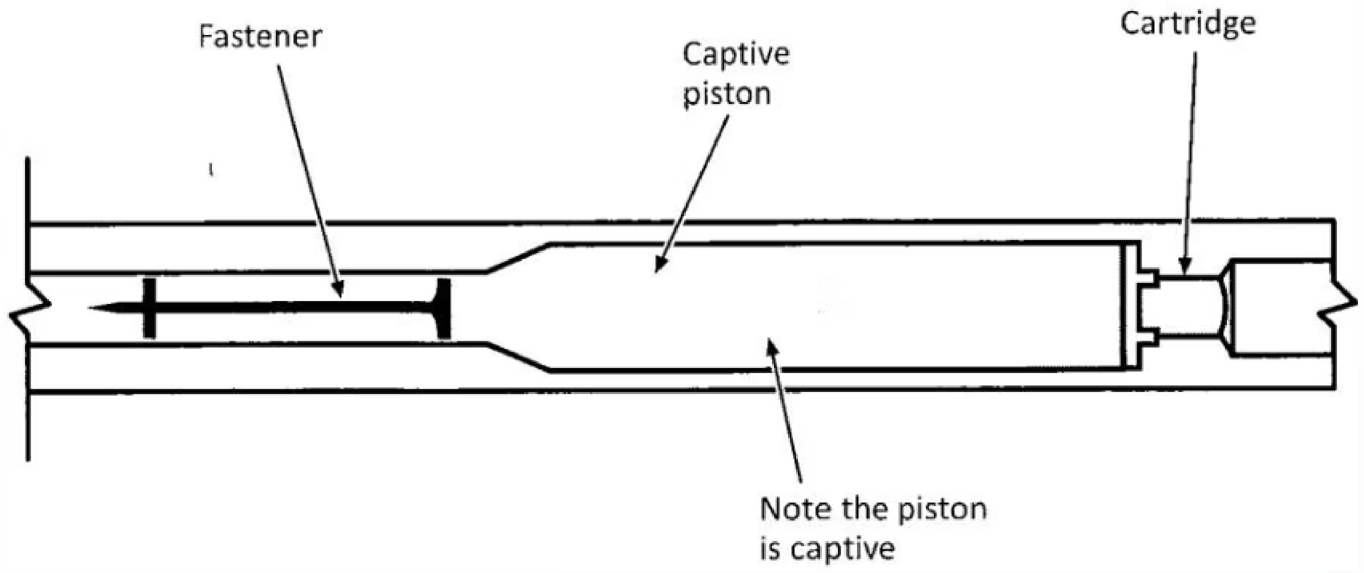
For general safety principles, consult manufacturer guidelines and safety resources.

Types of Powder-Actuated Tools

Low-Velocity (Hilti type)

Gas technicians/fitters mostly use the Hilti brand of low-velocity tool. It operates on the captive piston principle. In this type, both the fastening pin and the driving piston move at less than 100 m (325 ft) per second.

A built-in device prevents this type from firing if its flat end is held at more than 7° off the work surface. The fastener must be close to vertical to the work surface.

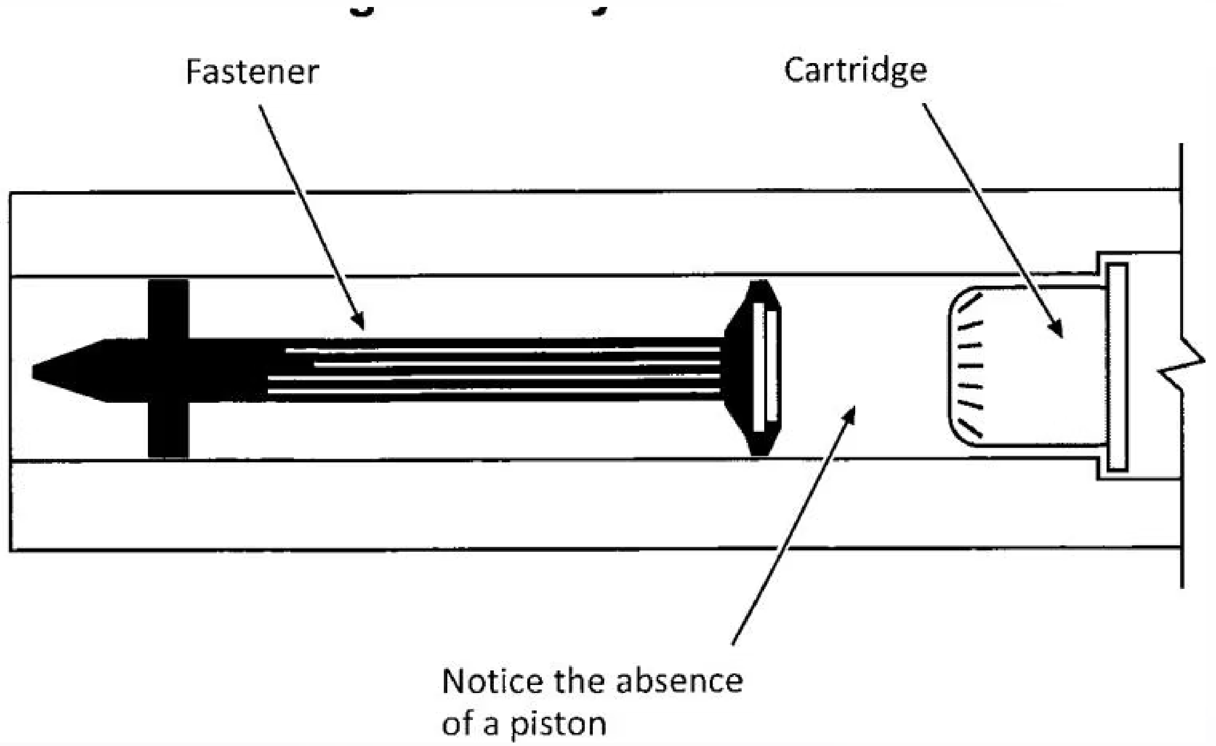


Medium-Velocity (Ramset type)

When fired, the fastening pin travels at about 325 to 500 ft (100 to 150 m) per second.

High-Velocity Tools

High-velocity tools have limited application. They have no piston, and the pin is discharged at a velocity above 500 ft (150 m) per second often up to 1500 ft (450 m) per second.



Powder-Actuated Tool Propulsion Methods

Impact Propulsion

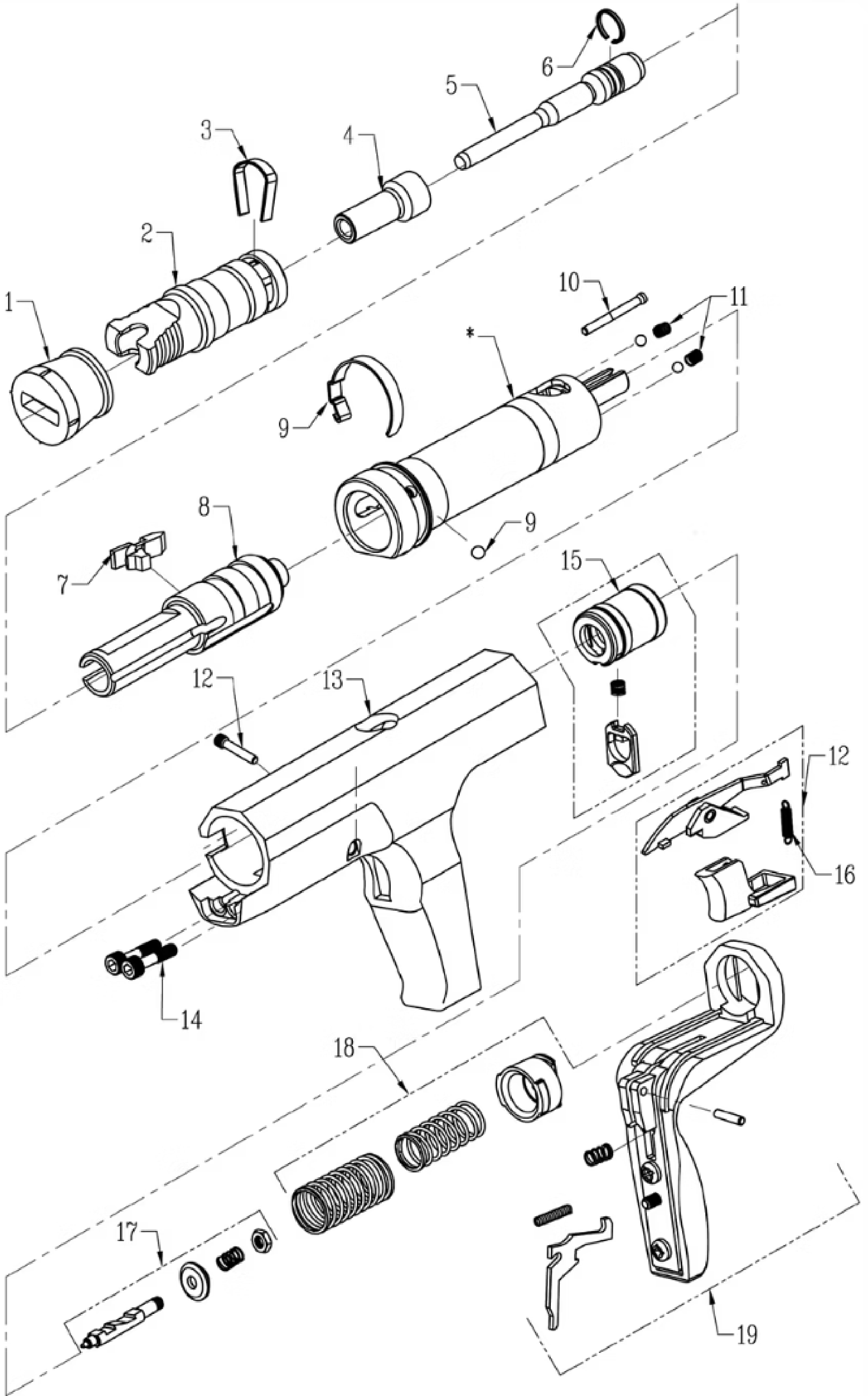
In this method, a gap exists between the fastener and the piston. A stop ring absorbs impact. For the tool to function properly, you must replace the stop ring when worn.

Contact Propulsion

In this method, the work surface, fastener, and piston are in direct contact.

Co-acting Propulsion

Only the piston and fastener are in contact. They are away from the work surface.



Cartridge Types and Powder Loads

Cartridge Case Identification

You can distinguish low- and high-velocity cartridges by their cases:

- Low-velocity cartridges have brass cases.
- Higher-velocity cartridges have nickel cases.

They are rated according to the same colour code. The weakest is gray, and the strongest purple.

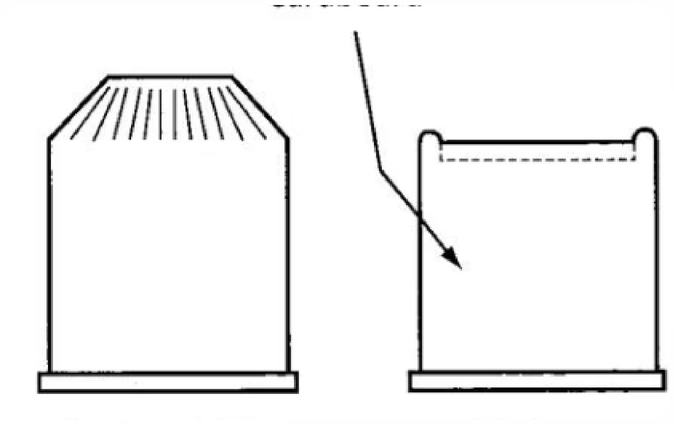
Hilti Cartridge Colour Code

From weakest to strongest:

- Grey
- Brown
- Green
- Yellow
- Red
- Purple

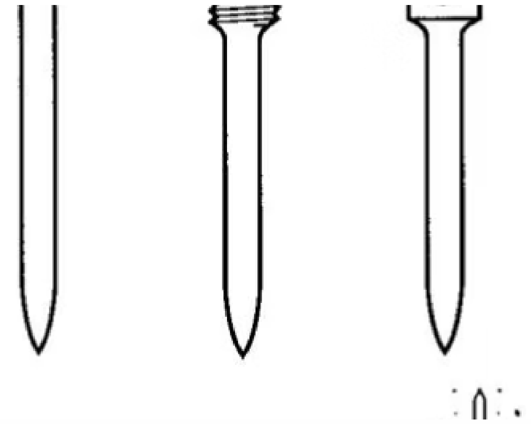
When selecting a cartridge for a powder load, start with the weakest load for the tool, then increase strength a step at a time until the proper fastening is obtained.

Cartridge Types and Fasteners



Crimped and Wadded Cartridges

Both provide the same power. They may be rim-fired or centre-fired. Hilti uses crimped cartridges and paints the tip to identify the strength of powder load. This paint also keeps the cartridge dry.



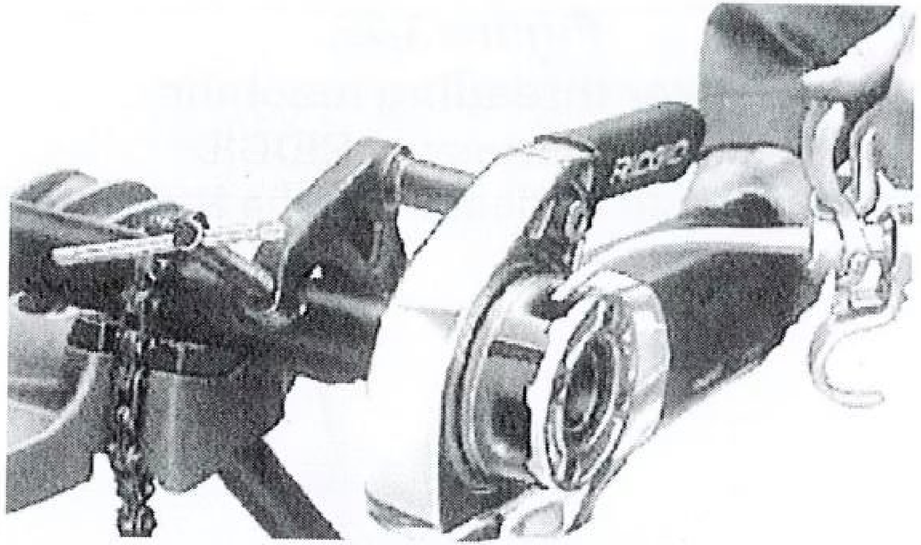
Basic Fastener Types

Powder-actuated tools fire three basic types of fasteners. The point of the fastener forces the work material aside just enough to let the fastener penetrate and "seat" properly, without deforming the material excessively.

Power Threaders

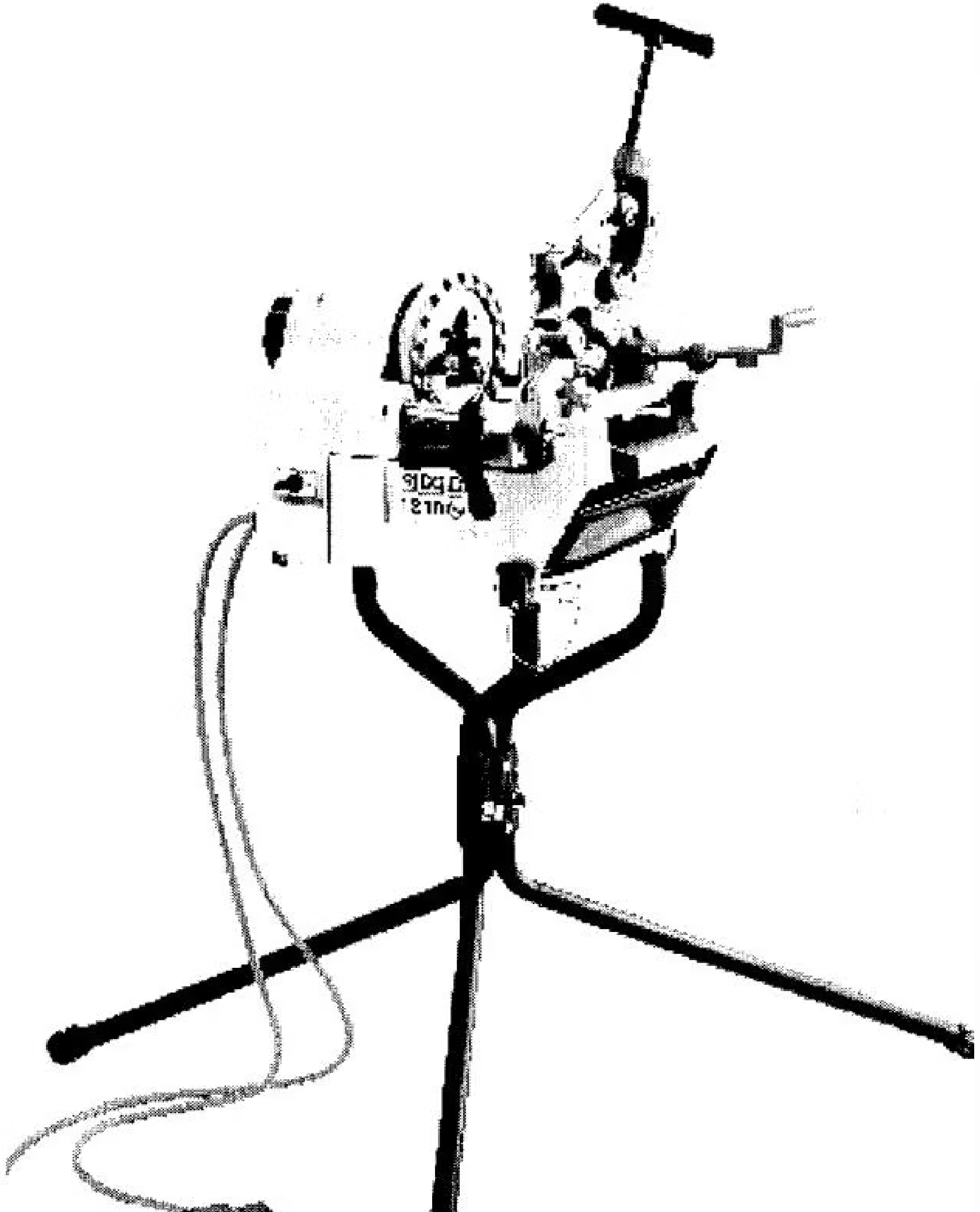
Hand-Held Power Threaders

These electrically powered machines are convenient for small jobs and are powerful enough (depending on the model/manufacturer) to thread pipe and/or rod utilizing sizes from 1/8" up to 2". They are light-weight in comparison to general, full-sized powered threading machines. However, you should use them in conjunction with an approved vice with support arm assembly.

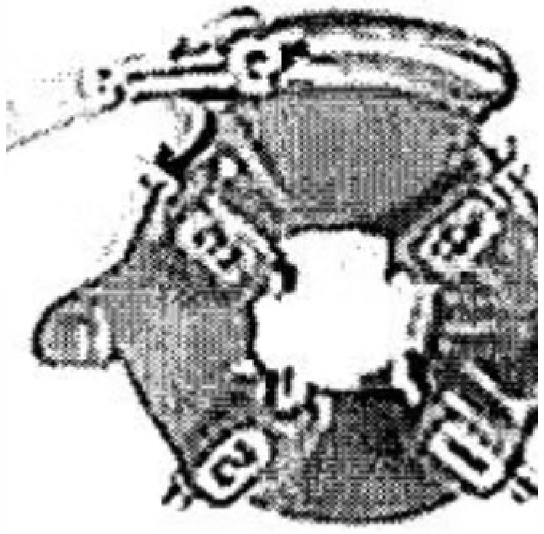
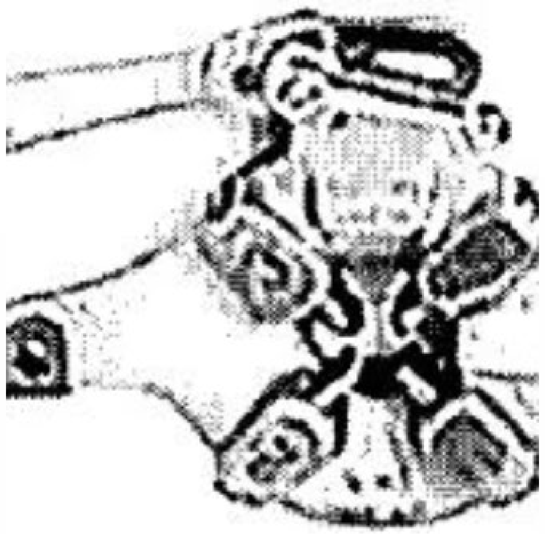
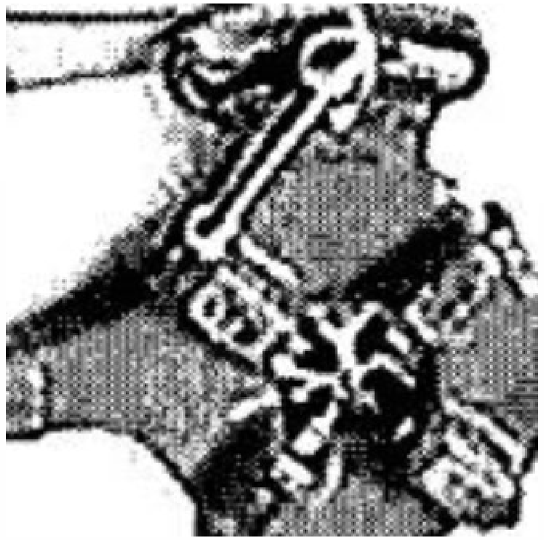


Powered Threading Machines

These electrically powered machines are convenient for medium to large jobs and are typically powerful enough to thread pipe and/or rod in any required size used for gas piping. There are many options for dies including ratchet type, mono as well as quick-opening, self-opening, and semi-automatic universal dies.



Threading Die Heads


Various styles of quick-opening threaders are designed for use on power equipment such as a power threading machine. They attach to a carriage assembly that also hosts a reamer and cutter. These types of die heads have a lever to release the dies from the pipe when the thread has been cut to the required length, eliminating the need to stop and back off after the thread has been cut.

CSA Unit 2

Chapter 4
Measuring Tools

The installation of piping systems and gas equipment involves measurement. This presentation provides descriptions and formulas for some of the basic measurement information, including the most commonly used measuring instruments and tools for gas technicians and fitters.

Objectives

Units of Measurement

Describe units of measurement and dimensions

Tool Selection

Describe requirements for selecting measuring tools

Tool Types

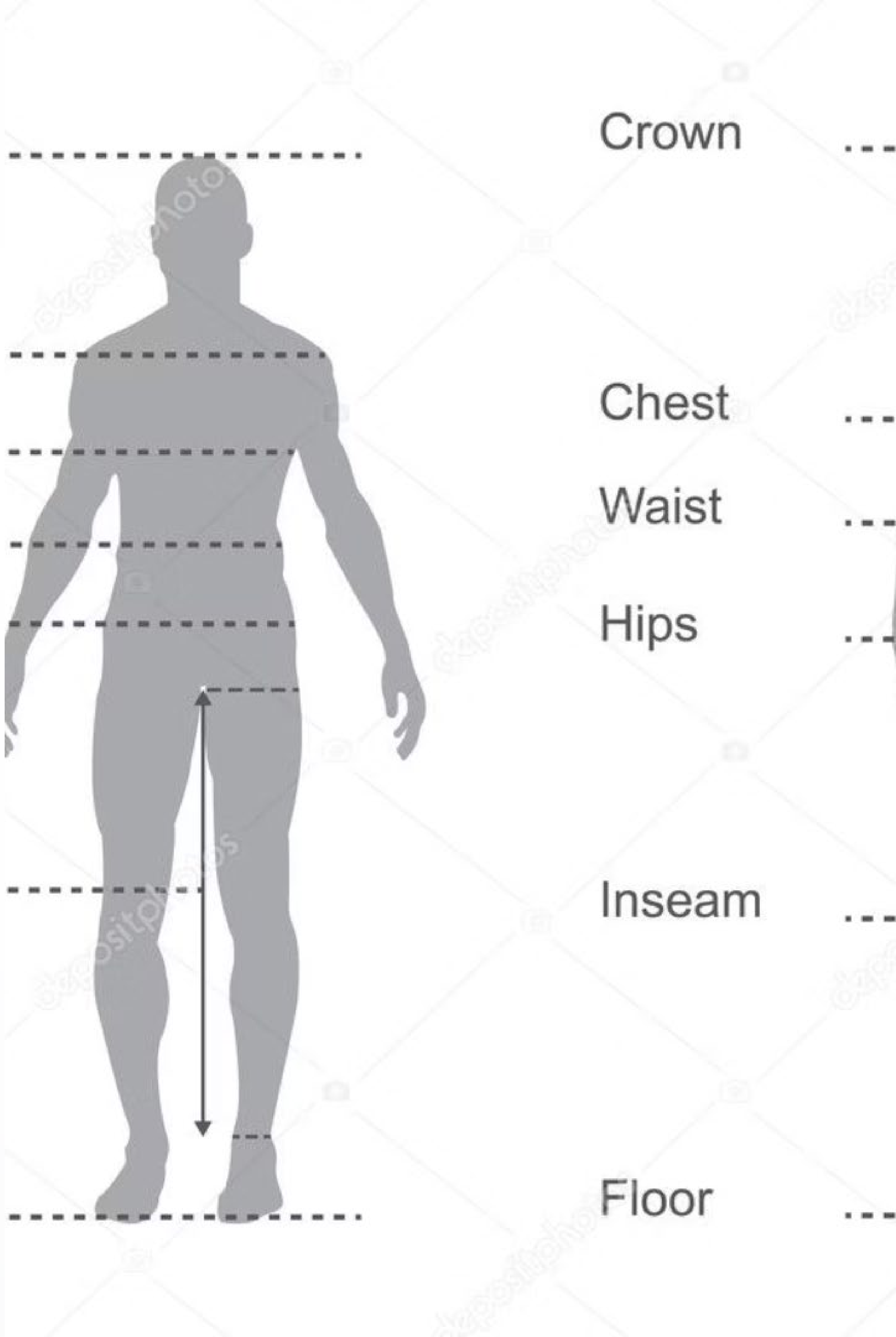
Identify types of measuring tools

Tool Usage

Describe the use of measuring tools

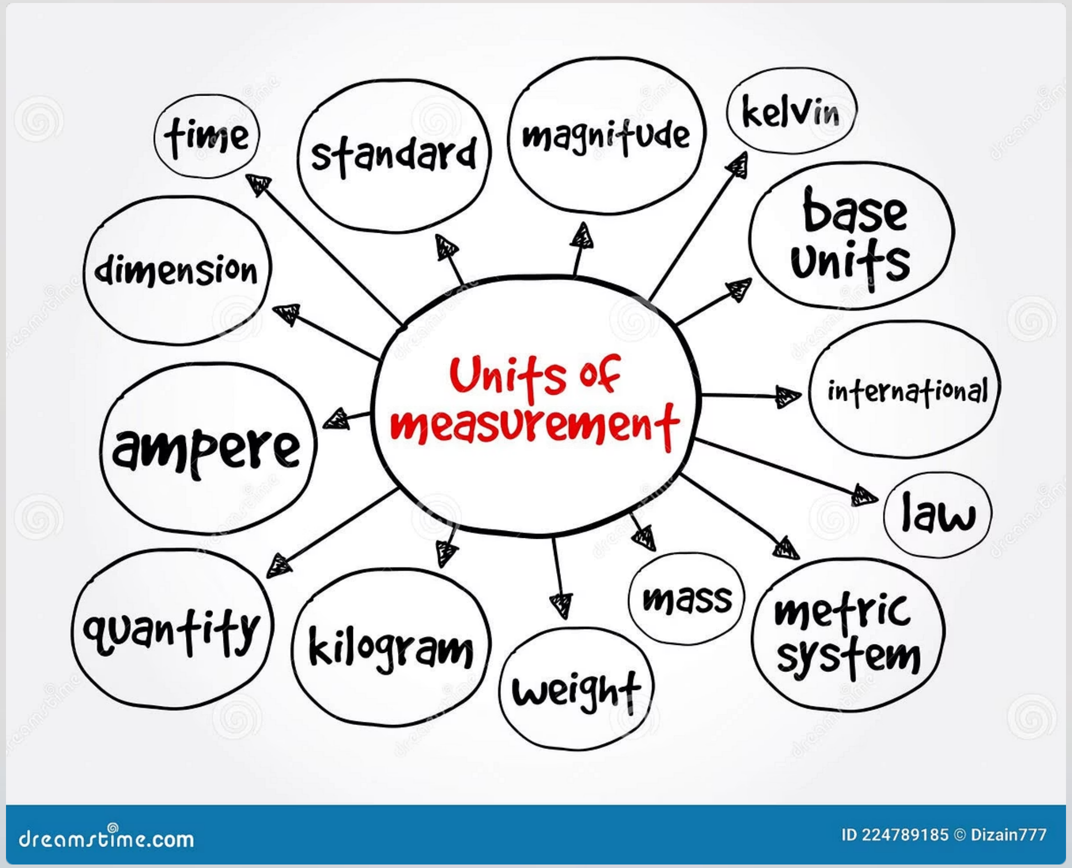
Key Terminology

Term	Abbreviation (symbol)	Definition
Area	A	The extent or measurement of a surface.
Circumference	C	The enclosing boundary of a curved geometric figure, especially a circle.
Cubic foot	ft^3	The volume of a cube with sides of one foot (0.3048 m) in length.
Cubic meter	m^3	The volume of a cube with edges one meter in length.



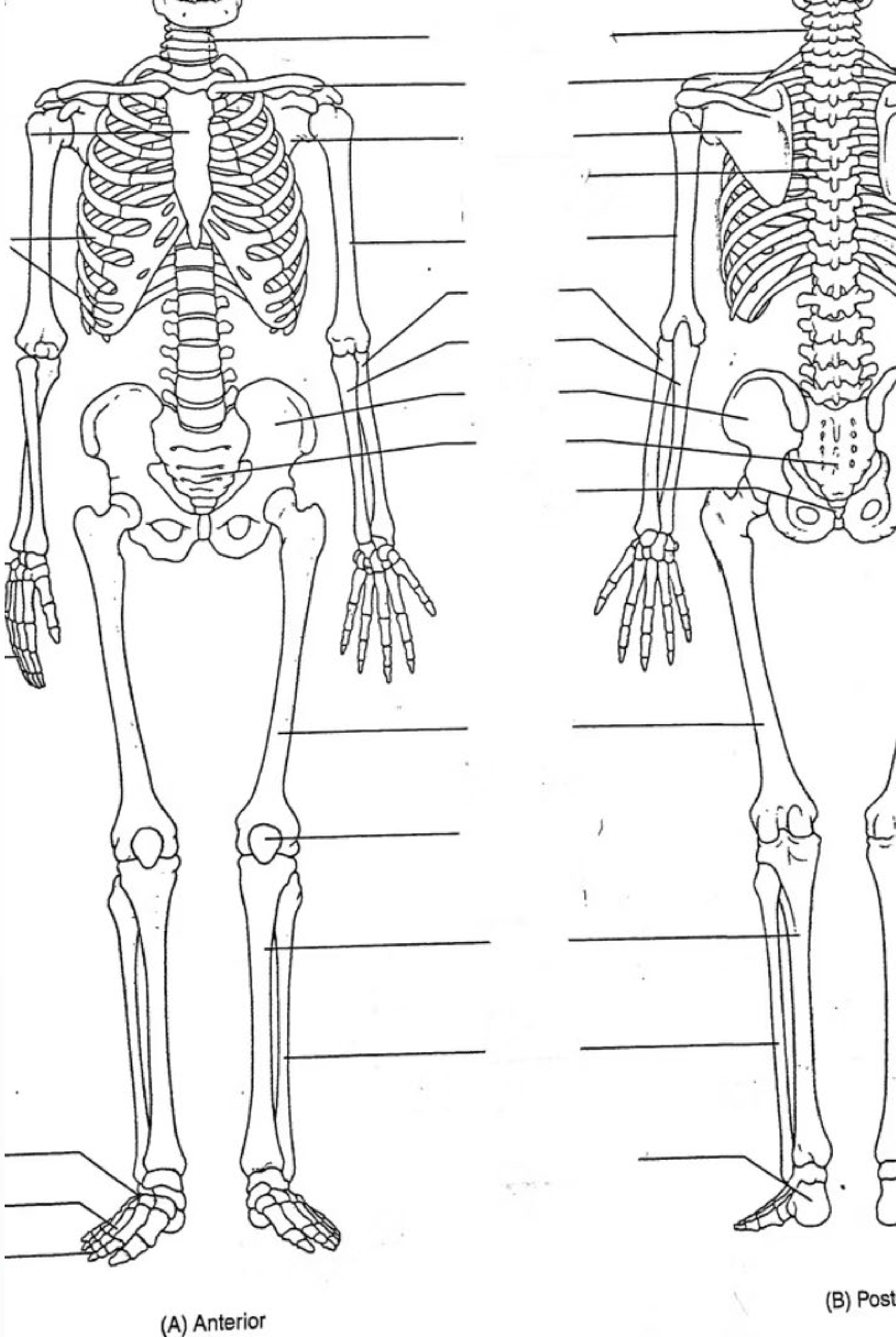
More Terminology

Term	Abbreviation (symbol)	Definition
Diameter	D	A straight line passing from side to side through the center of a body or figure, especially a circle or sphere.
Height	H	The measurement from base to top or (of a standing person) from head to foot.
Length	-	The measurement or extent of something from end to end.
Pi	π	The ratio of a circle's circumference to its diameter, commonly approximated as 3.1416.



Final Terminology

Term	Abbreviation (symbol)	Definition
Radius	R	A straight line from the center to the circumference of a circle or sphere.
Square feet	ft^2	The area of a square whose sides measure exactly one foot.
Square meters	m^2	The area of a square whose sides measure exactly one meter.
Volume	V	The amount of space that a substance or object occupies, or that is enclosed within a container, especially when great.
Width	W	The measurement or extent of something from side to side.



Measurement of Dimensions

Basic Measurements

Gas technicians/fitters usually measure the dimensions of solid objects with simple tools and methods. Some use more specialized tools.

Measurements can be categorized into:

- Straight line measurements
- Circular measurements
- Area calculations
- Volume calculations

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Gas technicians need to be proficient in various measurement techniques to ensure proper installation of piping systems and gas equipment.

Rectangular cube showing length, width, height, and area

Measurements Involving Straight Lines

Length, Width, and Height

Length (L), width (W), and height (H) are measured in straight lines from one point to another, usually with a ruler or measuring tape.

They are expressed in imperial units such as inches and feet, or metric units such as millimeters and meters.

Area

Area (A) of a rectangle is the product of its length and width. It is expressed in square units such as square feet (ft^2) or square meters (m^2).

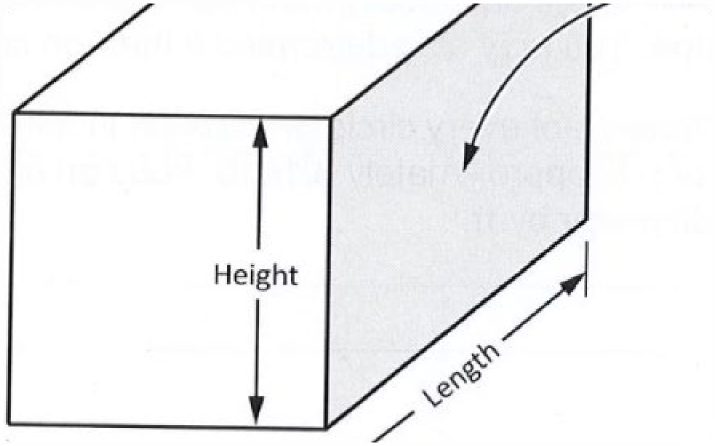
$A = L \times W$

Volume

Volume (V) of a cube is the product of its length, width, and height. It is expressed in cubic units such as cubic feet (ft^3) or cubic meters (m^3).

$V = L \times W \times H$

Rectangular Measurements

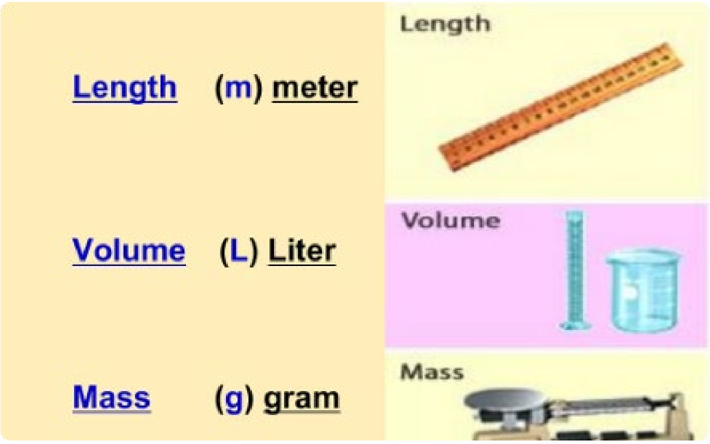


Length, Width, and Height

These basic dimensions form the foundation of all rectangular measurements. Gas technicians must be able to accurately measure these dimensions when installing piping systems and equipment.

Area Calculation

The area of a rectangle is calculated by multiplying length by width ($A = L \times W$). This is essential for determining surface areas of equipment installations.



Volume Calculation

The volume of a rectangular object is calculated by multiplying length, width, and height ($V = L \times W \times H$). This is important for determining space requirements for equipment.

Measurements Involving Circles

Diameter

The diameter (D) is measured like any other straight length, as the distance across the circle at its widest point.

A diameter divides the circle in half. Half of it is called the radius (R).

Circumference

The circumference (C) is the distance around the entire outside edge.

$C = \pi \times D = 2 \times \pi \times R$

Volume

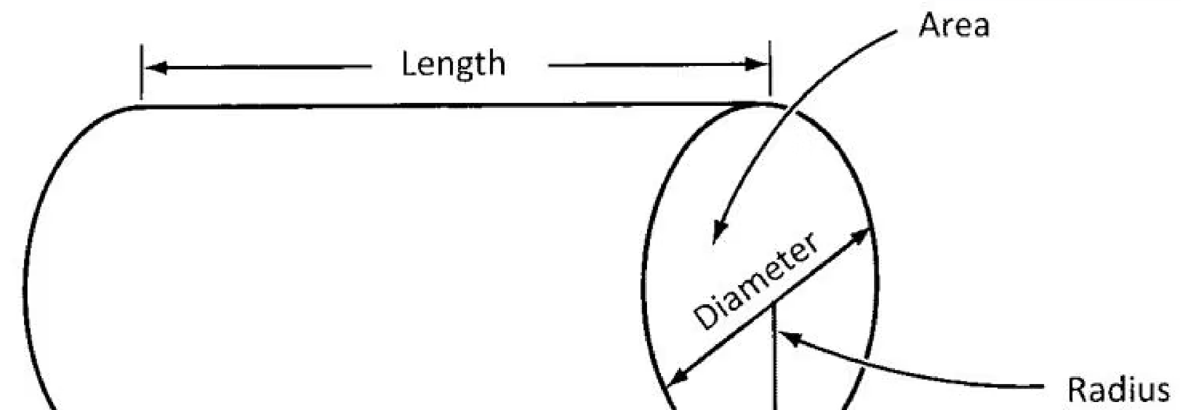
The volume of a cylinder is the product of the area of the circle and the cylinder's length.

$V = A \times L = 0.7854 \times D^2 \times L$

Area

The area of a circle is the product of pi and the square of the radius.

$A = \pi \times R^2 = 0.7854 \times D^2$



Cylinder Measurements

Cylinder Components

A cylinder has three key measurements:

- Diameter (D) - the width of the circular end
- Radius (R) - half the diameter
- Length (L) - the distance from one end to the other

These measurements are essential for gas technicians when working with pipes and cylindrical components.

The volume of a cylinder (such as pipe) is calculated using the formula:

Requirements for Selecting Measuring Tools

Type of Measurement

Consider what you're measuring: length, diameter, clearance, etc.

Size of Dimension

Consider the rough size of what you're measuring

Required Precision

How accurate does the measurement need to be?

Tool Accuracy

Consider the accuracy of available tools

Applications of Measurement

Measuring Components

Taking accurate measurements of pipes, fittings, and equipment

Aligning Components

Ensuring proper alignment of pipes and equipment during installation

Checking Sizes

Verifying that components and equipment meet specified dimensions

Storage and Maintenance of Measuring Tools

Handle with Care

Treat measuring tools gently to maintain their accuracy

Keep Clean

Maintain cleanliness while working with measuring tools

Use as Designed

Only use tools for their intended purpose

Oil Moving Parts

Apply thin coating of oil to moving parts

Proper Storage

Store in clean, dry environment

Types of Measuring Tools

Common Tools

- Hinged and jointed folding rules
- Spring-loaded tapes
- Squares
- Straight edges

Specialized Tools

- Drill gauges
- Feeler gauges
- Micrometers
- Calipers

Selection Criteria

- Accuracy requirements
- Measurement type
- Ease of use
- Durability

Spring-Loaded Tapes

Long Flexible Steel Tapes

Long flexible steel tapes are wound inside a carrying case. Their lengths range from 50 ft to 200 ft (15 m to 60 m).

- Longer metric tapes have markings every 2 mm
- Longer imperial tapes have markings every 1/8 in
- Include crank handle to retract the tape
- Hook at zero end can extend to brace against measured object
- Hook can fold to hook over a nail

Pocket Tapes

Most Common Measuring Device

The pocket-type or spring-loaded tape is the measuring device that gas technicians/fitters use most often. It is easy to carry, accurate, and long enough for most purposes.

Measurement Capabilities

Metric tapes have markings every millimeter. Imperial tapes have markings every 1/16 in or 1/32 in. You can use it for internal and external measurements.

Available Widths

Available tape widths are 1/2 in, 3/4 in, and 1 in (12 mm, 19 mm, and 25 mm). Wide tapes are more rigid when extended. Narrow blades are easier to carry.

Folding Rules

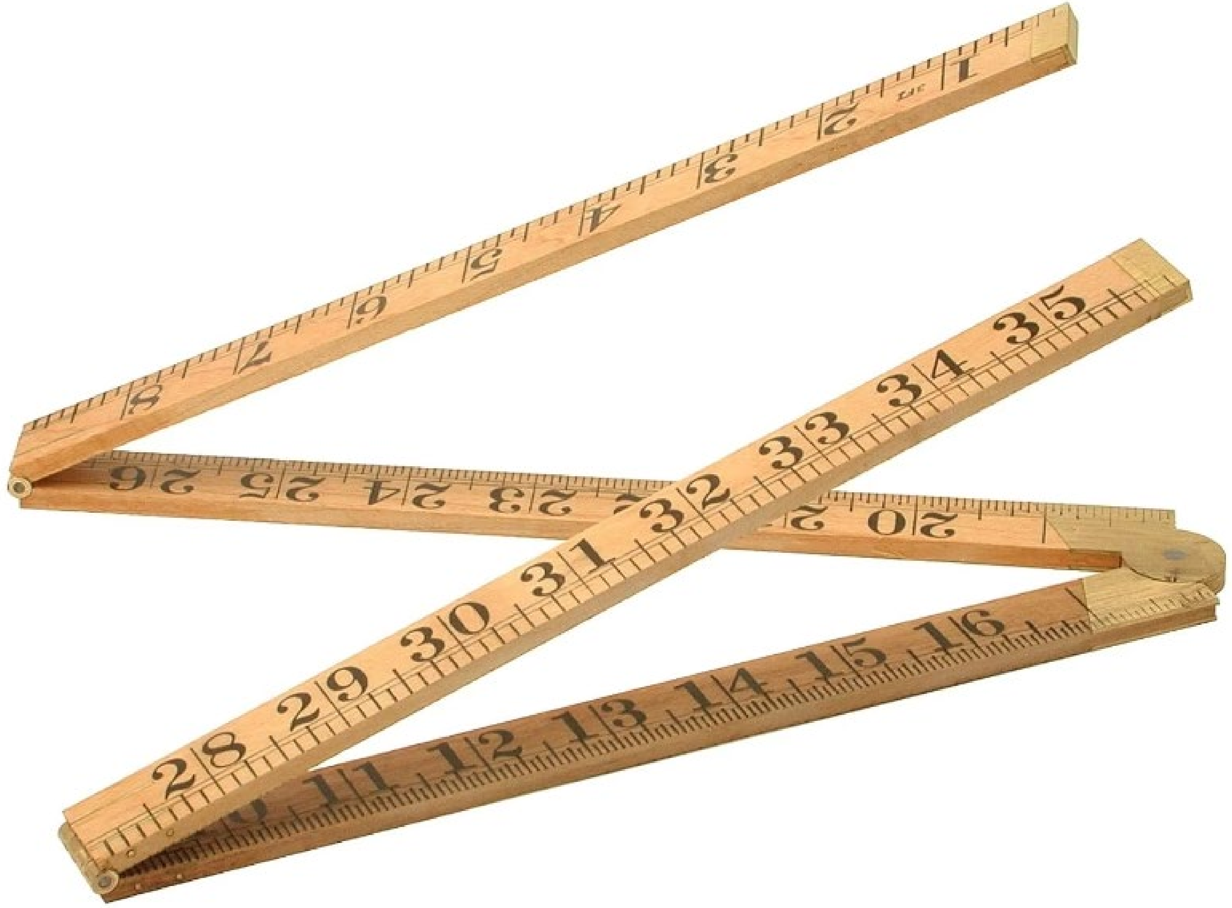
Types of Folding Rules

There are two basic types of folding rules:

- Hinged rules
- Spring-jointed rules

Both may be made of plastic, metal or wood.

Metric rules have markings every millimeter. Imperial rules have markings every 1/16 in or 1/32 in.



Folding rules fold to 6 in or 8 in (150 mm to 200 mm), so that you can easily carry them. When extended, folding rules are rigid and can span distances without sagging. This gives greater accuracy than a steel tape on long spans.

Squares and Straight Edges

Marking Straight Lines

Used for marking straight layout lines and some basic angles such as 90° and 45°

Layout Work

Used for laying out supports, brackets, and welded pipe

Squaring Equipment

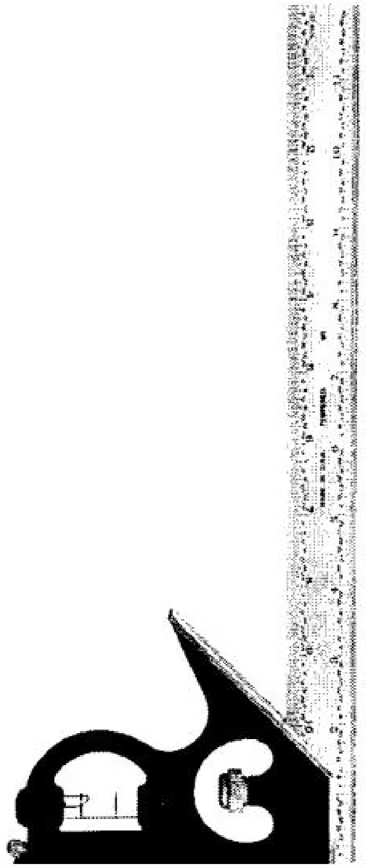
Used for squaring up pipe and other equipment

Framing Square

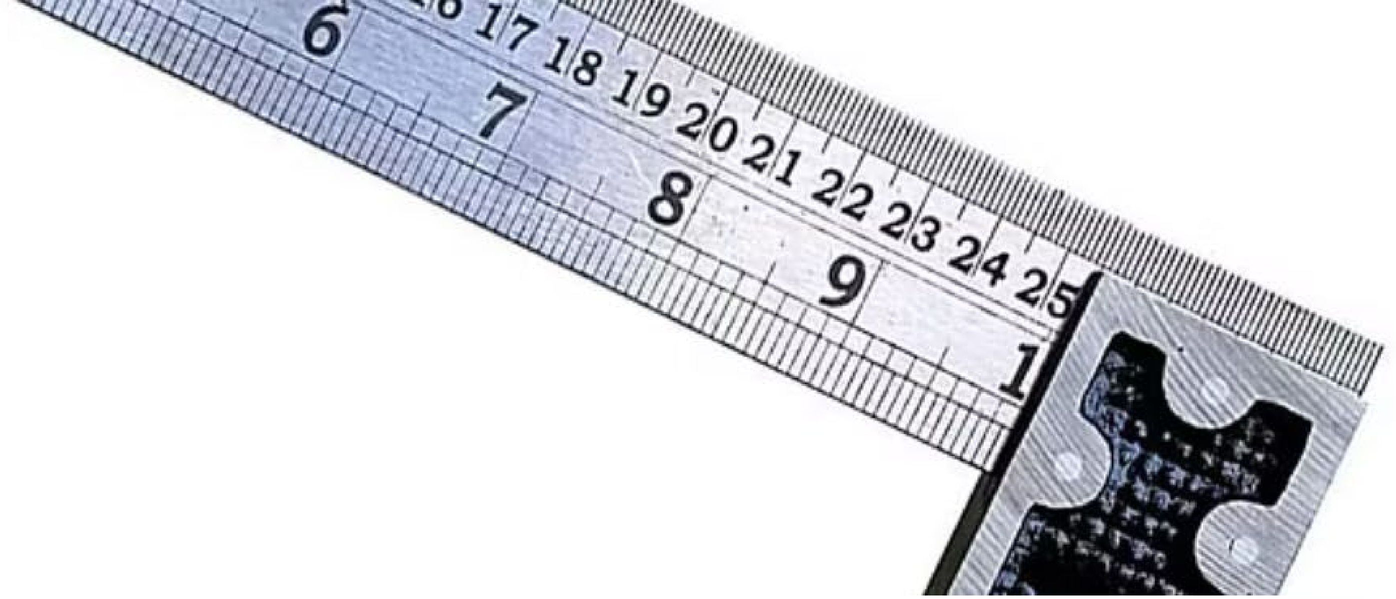
Common Square

The most common square is a right angle made up of a 2 ft (600 mm) long straight edge and a 16 in (400 mm) straight edge.

Gas technicians/fitters most often use it to lay out and fabricate welded pipe and fittings.



A framing square is an essential tool for ensuring right angles in pipe installations and equipment mounting.



Try Squares

Design

Single straight edge connected to a handle

Size

Blade lengths usually 6-10 in (150-250 mm)

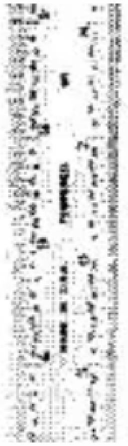
Usage

Used on smaller work pieces

Variants

Include miter squares for 45° angles

Combination Squares



Design Features

The combination square has an adjustable head that can be fixed anywhere along its length. The steel rule is 12 in (300 mm) long. The head has one edge at 90° to the blade and another at 45°.

Marking Angles

Used for marking 90° and 45° angles in pipe installation work.

Multiple Functions

Can be used as a depth gauge, marker gauge, and for marking lines parallel to the edge of a work piece at a set distance.

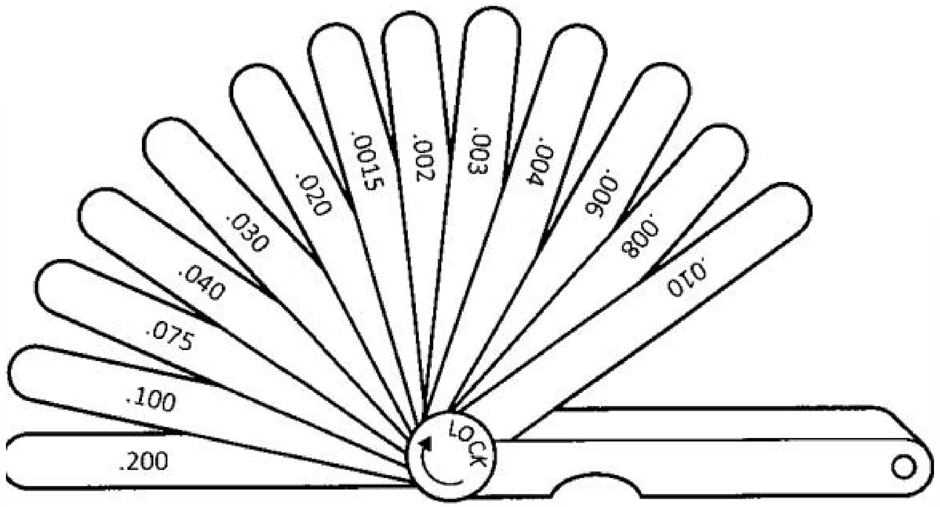
Feeler Gauges

Purpose and Use

Gas technicians/fitters use feeler gauges to determine the amount of clearance between parts, such as the spark plug gaps on spark igniters.

These precision tools consist of multiple thin metal strips of varying thicknesses that can be inserted into gaps to measure clearance.

Figure 4-5
Set of feeler gauges



Feeler gauges are essential for precise measurements of small gaps in gas equipment, ensuring proper functioning and safety.

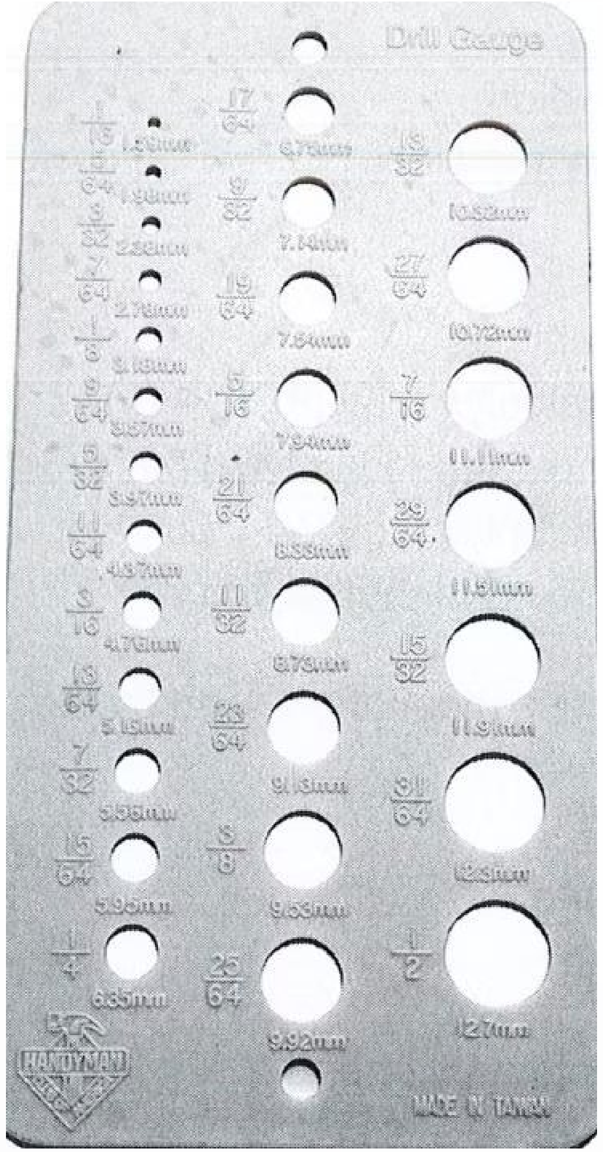
Drill Gauges

Function and Types

A drill gauge helps measure the diameter of drill bits. It is available in:

- Metric sizes
- Letter sizes
- Fractional sizes

This tool is particularly useful when selecting the correct drill bit size for specific applications in gas installation work.



Drill gauges provide a quick and accurate way to verify drill bit sizes, ensuring proper hole dimensions for gas fittings and components.

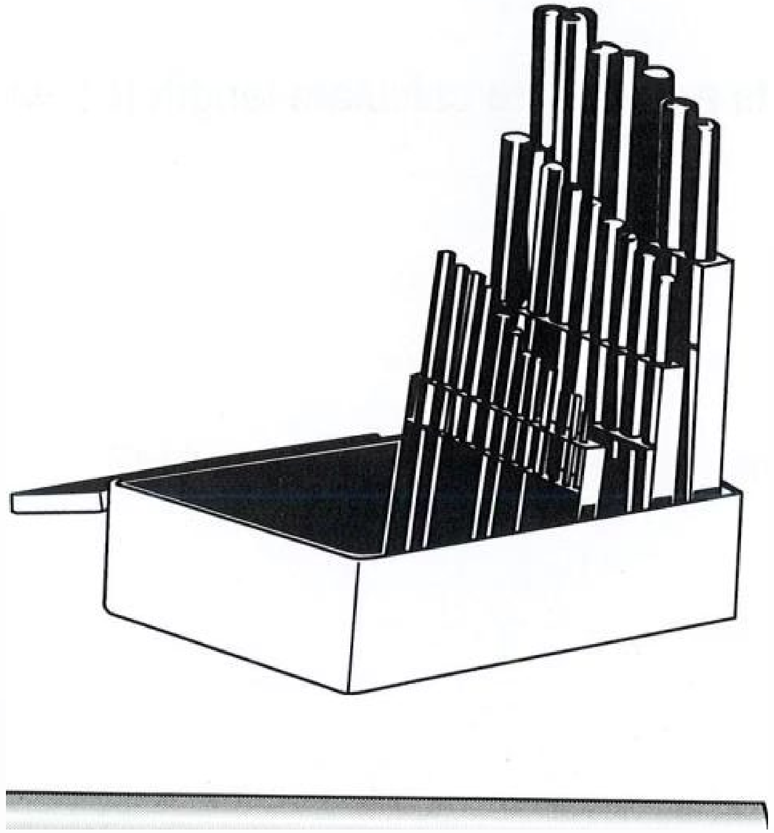
Drill Bit Blanks

Purpose and Application

A drill bit blank measures the size of a small hole. Typically, gas technicians/fitters use it to measure the size of a gas orifice.

This specialized tool is critical for ensuring that gas orifices are the correct size, which directly affects gas flow and equipment performance.

Figure 4-7
Drill bit blank



Accurate measurement of gas orifices is essential for proper gas flow and safe operation of gas equipment.

Measuring Length in Gas Installation

Select Appropriate Tool

Choose between tape measure, folding rule, or other measuring device based on the distance and required accuracy.

Position and Align

Ensure the measuring tool is properly positioned at the starting point and aligned with the dimension being measured.

Read Measurement

Take the reading at the end point, being careful to note the correct unit (imperial or metric) and subdivision.

Verify Accuracy

Double-check the measurement, especially for critical dimensions that affect system performance or safety.

Measuring Pipe Diameter

Select Tool

Choose appropriate measuring tool (tape, caliper, etc.)

Measure Outside

Measure the outside diameter of the pipe

Calculate Inside

Subtract wall thickness (if needed) to find inside diameter

Verify Size

Confirm measurement matches required specifications

Calculating Pipe Circumference

Formula and Process

The circumference (C) of a pipe is calculated using the formula:

$C = \pi \times D = 2 \times \pi \times R$

Where:

- π (pi) is approximately 3.1416
- D is the diameter of the pipe
- R is the radius of the pipe (half the diameter)

Knowing the circumference is essential when:

- Wrapping materials around pipes
- Determining pipe size for fittings
- Calculating material requirements

Calculating Pipe Area

π

Pi Value

Approximately 3.1416

R^2

Radius Squared

Radius multiplied by itself

0.7854

Simplified Factor

$\pi/4$ for diameter-based calculation

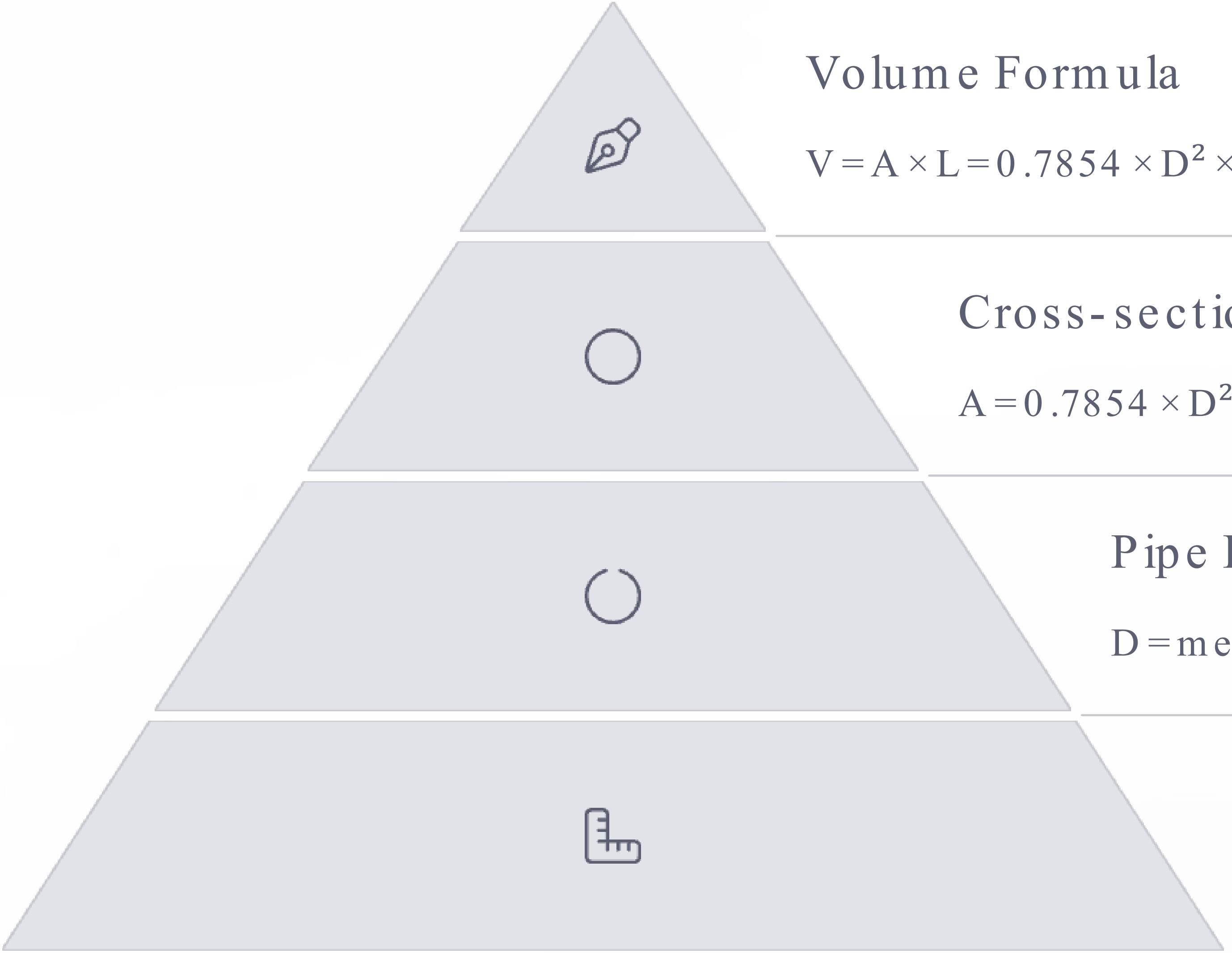
D^2

Diameter Squared

Diameter multiplied by itself

The area of a pipe's cross-section is calculated using the formula: $A = \pi \times R^2 = 0.7854 \times D^2$. This calculation is essential for determining flow capacity and sizing requirements for gas systems.

Calculating Pipe Volume



Volume Formula

$V = A \times L = 0.7854 \times D^2 \times L$

Cross-sectional Area

$A = 0.7854 \times D^2$

Pipe Diameter

D = measured diameter in consistent units

Pipe Length

L = measured length in consistent units

Calculating pipe volume is essential for determining the amount of gas a pipe can hold, which affects system design, purging requirements, and safety considerations in gas installations.

Importance of Accurate Measurements

Safety

Accurate measurements ensure proper fit of components, reducing the risk of gas leaks and potential hazards.

- Prevents loose connections
- Ensures proper clearances
- Maintains system integrity

Performance

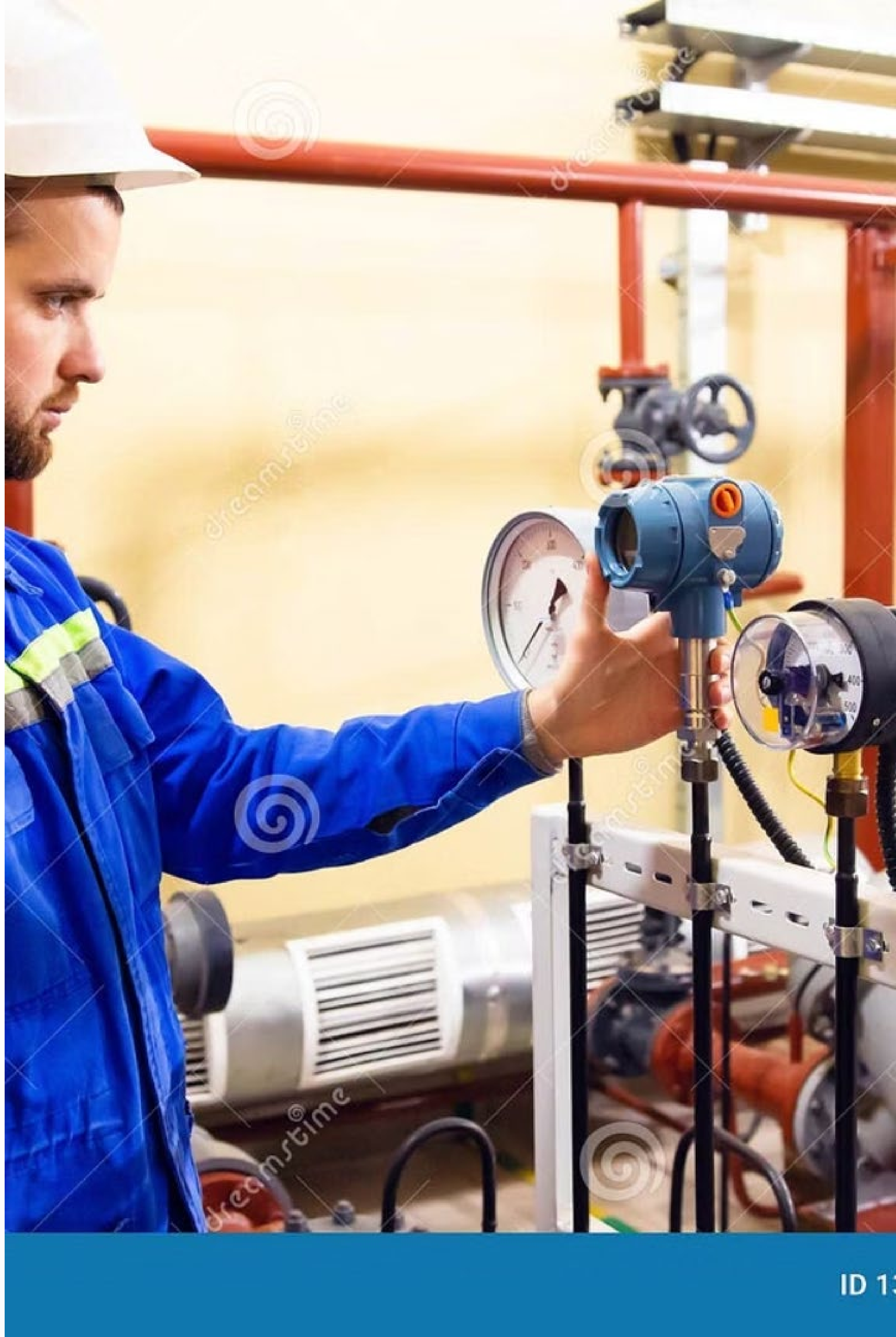
Precise measurements contribute to optimal system performance and efficiency.

- Proper gas flow rates
- Correct pressure drops
- Efficient operation

Cost Effectiveness

Accurate measurements reduce waste and rework, saving time and materials.

- Minimizes material waste
- Reduces labor costs
- Prevents expensive corrections



Common Measurement Errors

Reading Error

Misreading the scale or markings on measuring tools

Alignment Error

Improper alignment of measuring tool with the object being measured

Tension Error

Inconsistent tension when using flexible measuring tapes

Temperature Effects

Expansion or contraction of materials due to temperature changes

Tool Selection Error

Using the wrong tool for the type of measurement needed

Measuring for Pipe Fittings

Elbow Fittings

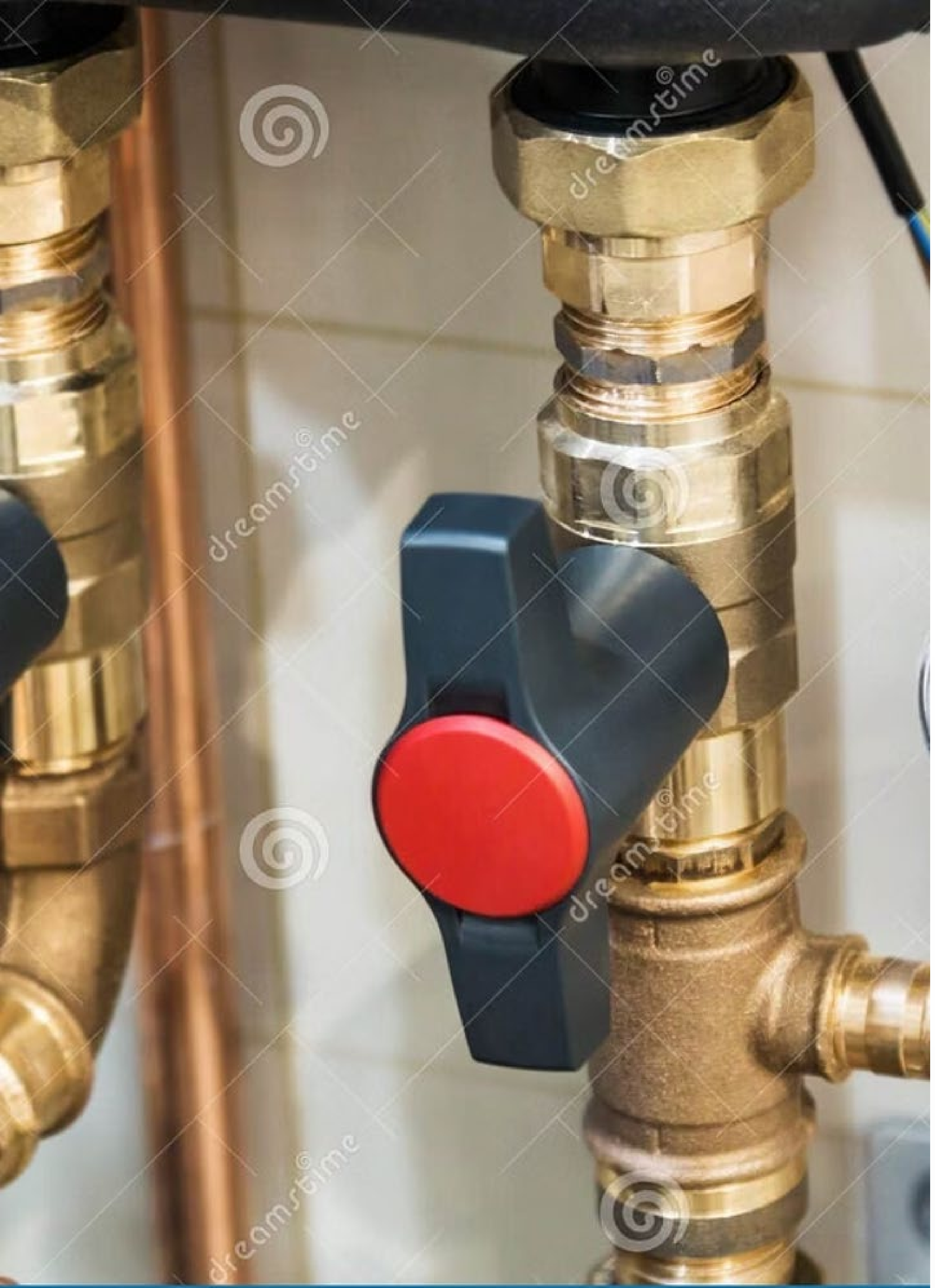
When measuring for elbow fittings, account for the center-to-end dimensions of the fitting. Measure from the center point of the bend to each end of the fitting.

Tee Fittings

For tee fittings, measure the center-to-end dimensions for all three openings. Consider the flow direction and orientation requirements.

Couplings

When measuring for couplings, account for the insertion depth of the pipe into the fitting. This ensures proper connection and alignment.



Measuring for Equipment Installation

Space Requirements

Measure available space for equipment installation

Clearance Requirements

Verify minimum clearances for safety and maintenance

Connection Points

Measure locations of gas, electrical, and ventilation connections

Support Structures

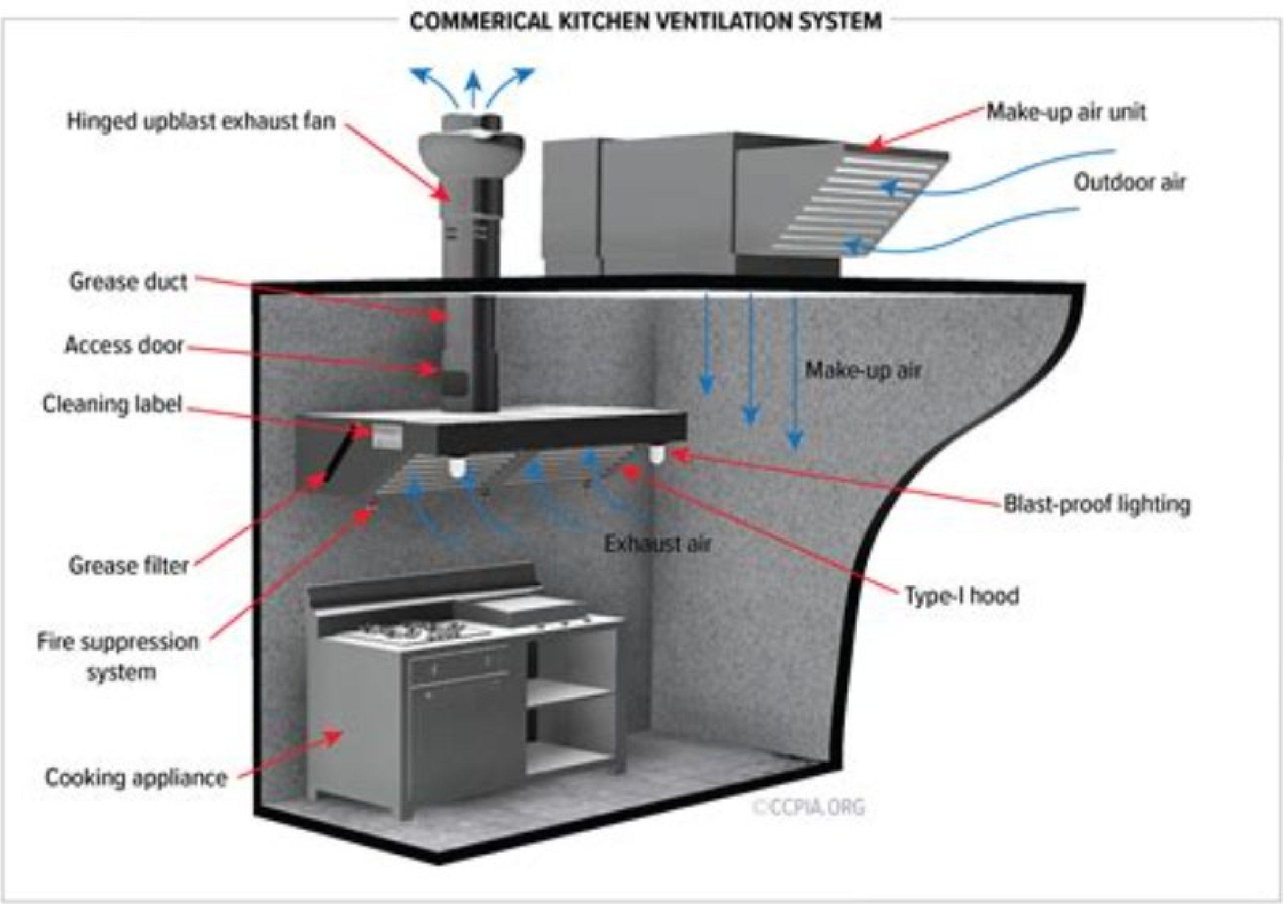
Determine measurements for mounting brackets and supports

Measuring for Ventilation Requirements

Critical Measurements

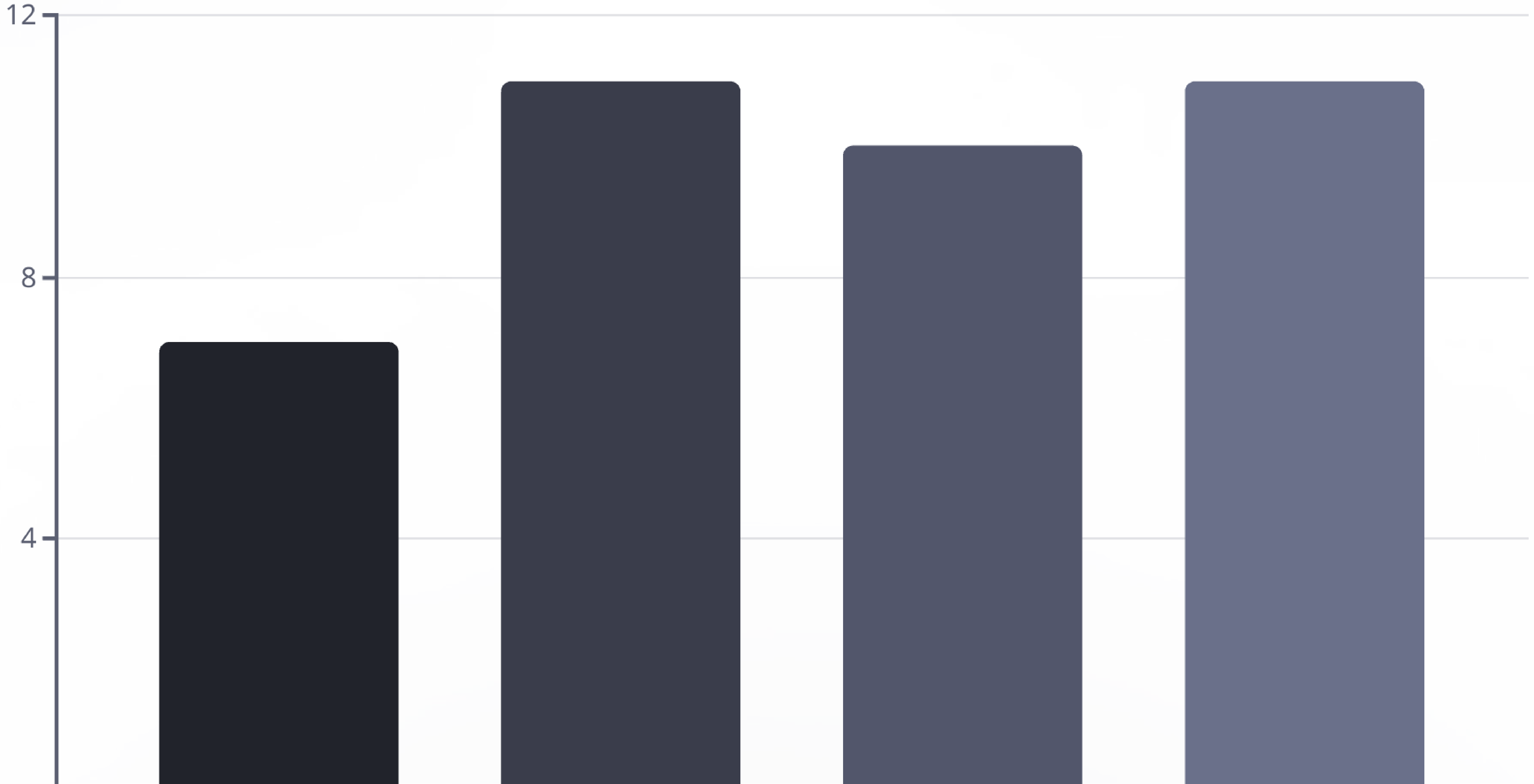
When installing gas equipment, proper ventilation is essential for safety. Key measurements include:

- Room volume (L × W × H)
- Vent opening sizes
- Clearances to combustible materials
- Flue pipe dimensions
- Distance to air intake and exhaust terminations



Accurate measurements ensure that gas equipment receives adequate combustion air and that combustion products are safely vented to the outside, preventing dangerous conditions like carbon monoxide buildup.

Measuring Gas Pressure



Measuring Gas Flow Rates

Flow Rate Measurement

Gas flow rates are typically measured in:

- Cubic feet per hour (CFH)
- Cubic meters per hour (m^3/h)
- British Thermal Units per hour (BTU/h)

Accurate flow measurements ensure that equipment receives the proper amount of gas for safe and efficient operation.

Flow rate measurements are essential for:

Digital Measuring Tools

Laser Distance Meters

Modern laser distance meters provide highly accurate measurements over long distances. They can measure length, area, and volume with the press of a button.

Digital Calipers

Digital calipers offer precise measurements of pipe diameters, wall thicknesses, and other small dimensions with digital readouts for easy reading.

Digital Angle Finders

These tools provide accurate angle measurements for pipe bends, slopes, and alignments, ensuring proper installation of gas piping systems.

Specialized Gas Industry Measuring Tools

Gas Pressure Gauges

Specialized gauges for measuring gas pressure in inches of water column (inwc) or millibars. Essential for setting and verifying proper gas pressure to equipment.

Gas Leak Detectors

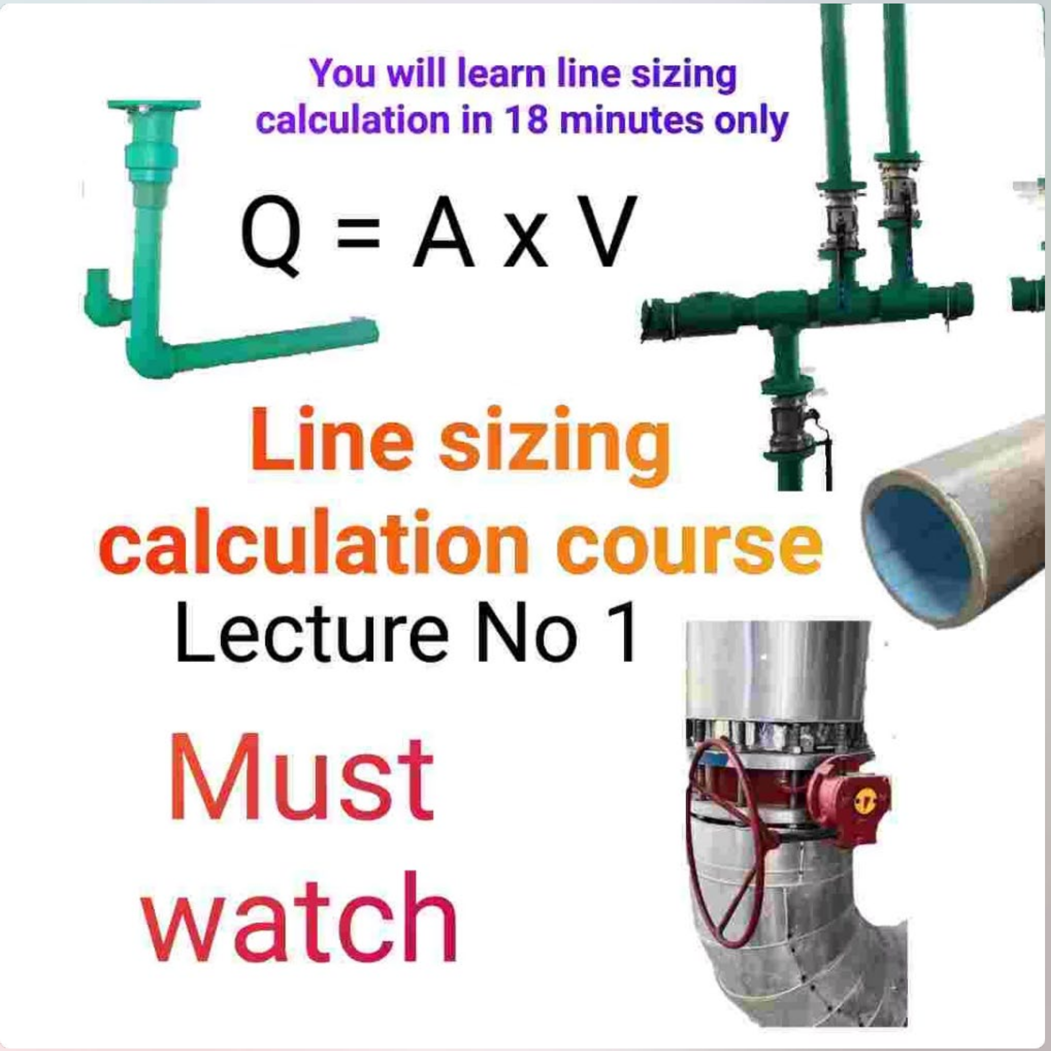
Tools that measure the concentration of gas in parts per million (ppm) to detect and locate gas leaks in piping systems and equipment.

Combustion Analyzers

Instruments that measure oxygen, carbon monoxide, and other gases in flue products to ensure proper combustion and safe operation.

Flow Meters

Devices that measure the volume or mass flow rate of gas through piping systems, ensuring proper supply to equipment.



Measuring for Gas Pipe Sizing

Determine Total Load

Calculate the total gas load in BTU/h or cubic feet per hour based on all connected appliances.

Measure Pipe Run Length

Measure the length of each pipe segment from the meter to each appliance, including all fittings.

Account for Fittings

Add equivalent lengths for each fitting to the measured pipe length to determine the total effective length.

Select Pipe Size

Use sizing tables to determine the appropriate pipe diameter based on load, length, and allowable pressure drop.

Measuring Clearances for Safety

Combustible Materials

Measure clearances from gas equipment to combustible materials according to manufacturer specifications and code requirements

Service Access

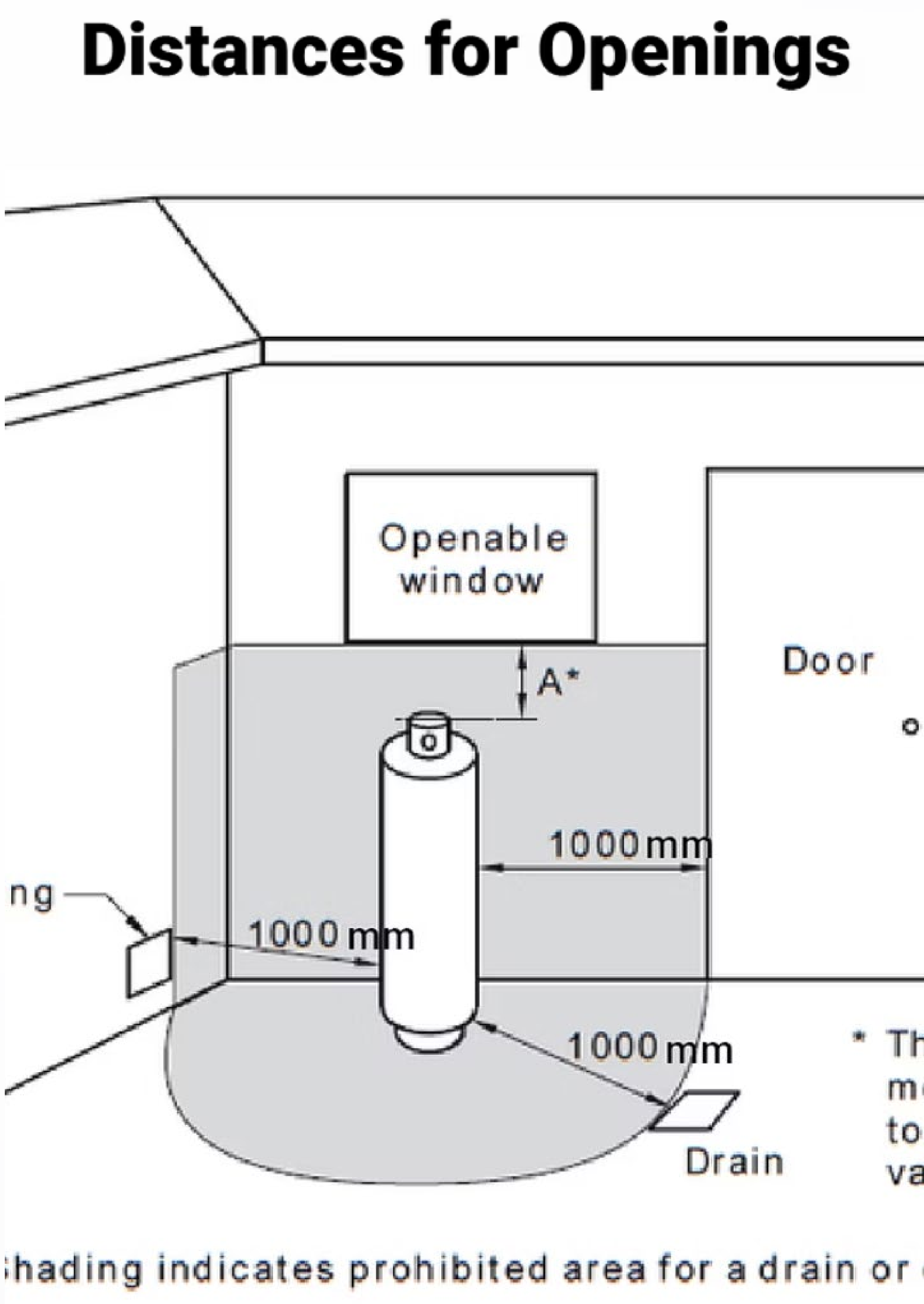
Ensure adequate clearance for service and maintenance of gas equipment

Ventilation Openings

Verify proper size and location of combustion air openings

Exhaust Terminations

Measure distances from vent terminations to windows, doors, and other building openings

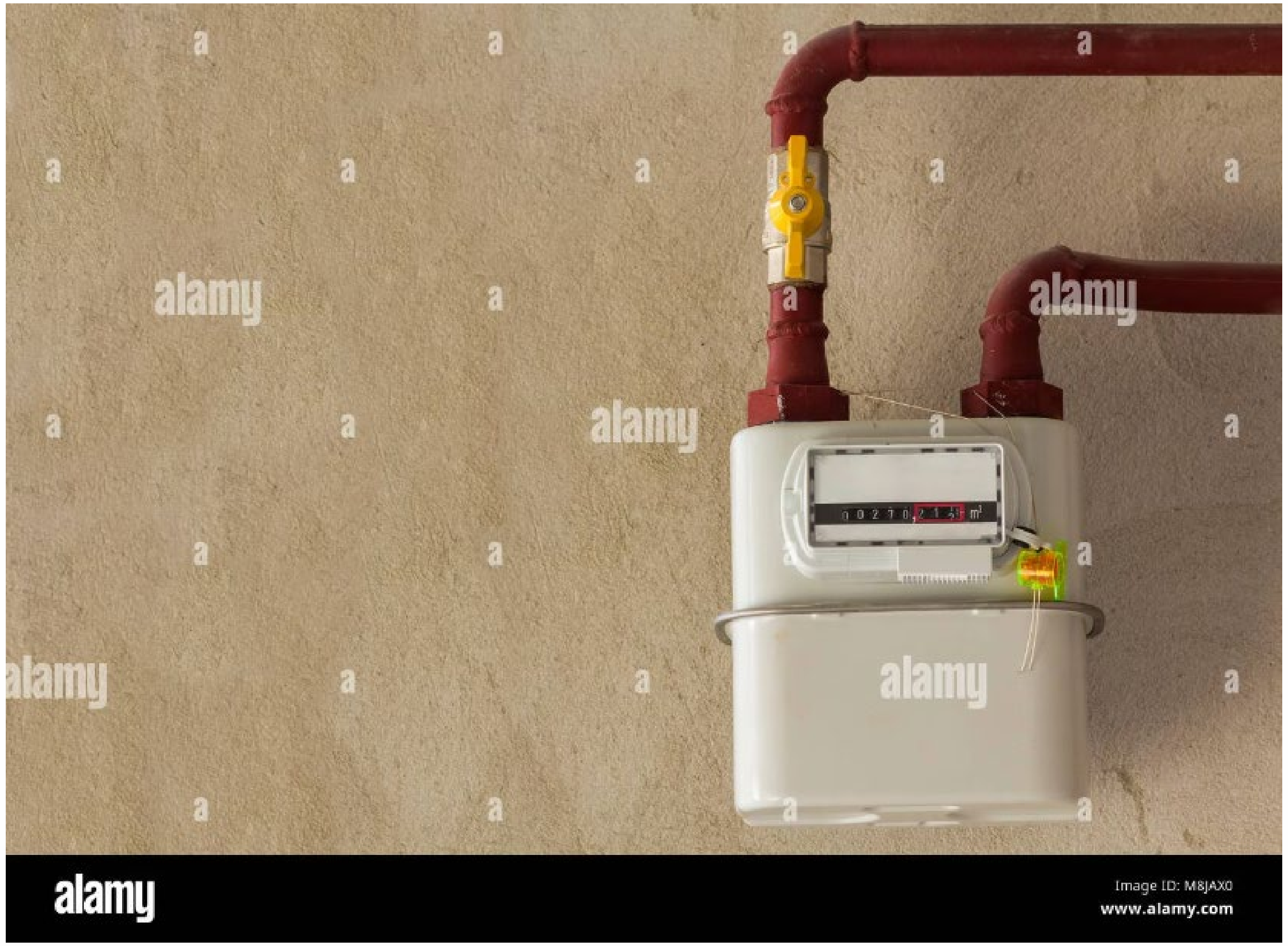


Measuring for Gas Meter Installation

Critical Measurements

When installing gas meters, several key measurements must be considered:

- Height from ground level
- Clearance from electrical equipment
- Distance from ignition sources
- Accessibility for reading and service
- Protection from physical damage
- Distance from building openings



Proper measurements ensure that gas meters are installed safely, comply with local codes, and remain accessible for utility personnel. Incorrect placement can create safety hazards and may require costly relocation.

Measuring Thread Sizes

Threads Per Inch	Diameter (Inches)	Diameter (In^2)	Area (In^2)
1 - 8	0.9188	0.551	0.606
1⅛ - 8	1.0438	0.728	0.790
1¼ - 8	1.1688	0.929	1.000
1⅜ - 8	1.2938	1.155	1.233
1½ - 8	1.4188	1.405	1.492
1⅝ - 8	1.5438	1.68	1.78
1¾ - 8	1.6688	1.98	2.08
1⅞ - 8	1.7938	2.30	2.41
2 - 8	1.9188	2.65	2.77
2¼ - 8	2.1688	3.42	3.56
2½ - 8	2.4188	4.29	4.44
2¾ - 8	2.6688	5.26	5.43
3 - 8	2.9188	6.32	6.51
3¼ - 8	3.1688	7.49	7.69
3½ - 8	3.4188	8.75	8.96
3¾ - 8	3.6688	10.11	10.34

Thread Gauges

Thread gauges are specialized tools used to measure the size and pitch of pipe threads. They help ensure proper matching of threaded components.

Nominal Pipe Size

Pipe threads are specified by nominal pipe size (NPS), which relates to the approximate internal diameter. Accurate measurement is essential for proper connections.

Thread Pitch

The pitch of pipe threads (threads per inch) must be measured to ensure compatibility between components. Standard pipe threads typically use NPT (National Pipe Thread) specifications.

Measuring for Pipe Support

Load Calculation

Determine weight of pipe, fittings, and contents

Support Spacing

Measure maximum distance between supports

Expansion Allowance

Measure space needed for thermal expansion

Height Measurement

Determine proper height for level installation

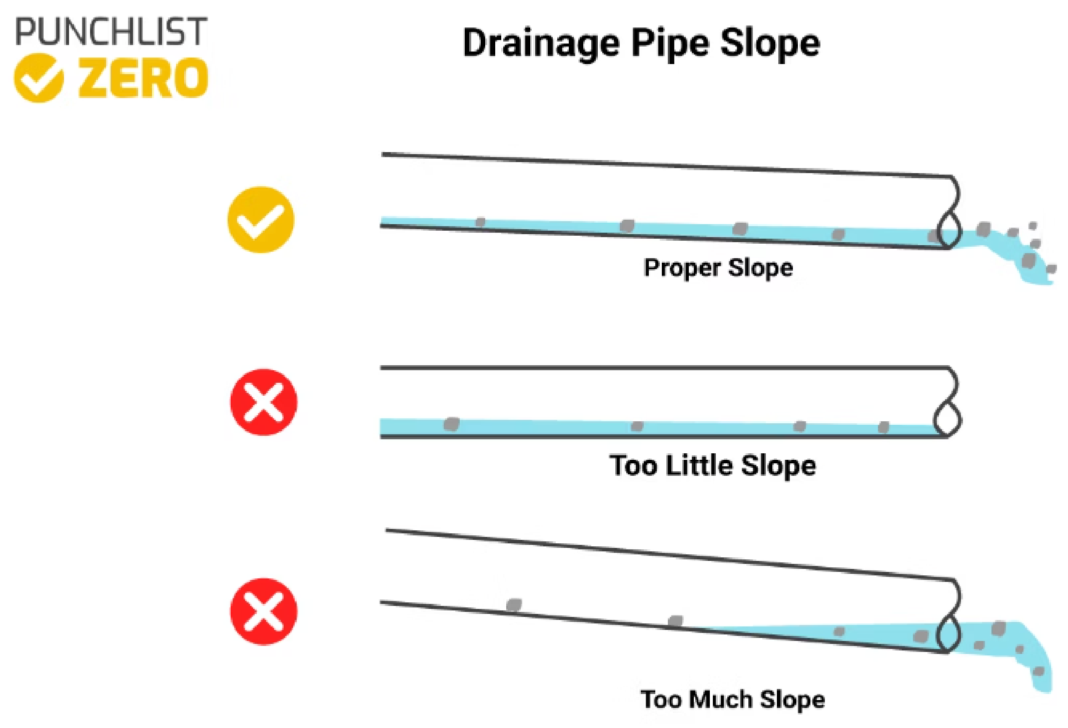
Measuring Pipe Slope for Drainage

Slope Calculation

Gas piping systems often require a specific slope to allow condensate to drain properly. The slope is typically measured in:

- Inches per foot
- Millimeters per meter
- Percentage grade

Common minimum slope requirements are 1/4 inch per foot (approximately 2%) toward the drip point.



Tools for measuring slope include:

- Bubble levels with slope indicators
- Digital inclinometers
- Laser levels with grade function
- Traditional level and measuring tape combination

Measuring for Seismic Restraints

Seismic Zone

Determine the seismic zone requirements for the installation location

Equipment Weight

Measure the weight of gas equipment requiring restraint

Center of Gravity

Locate the center of gravity for proper restraint placement

Anchor Points

Measure distances to suitable structural anchor points

Movement Clearance

Allow for measured clearance for limited movement during seismic events

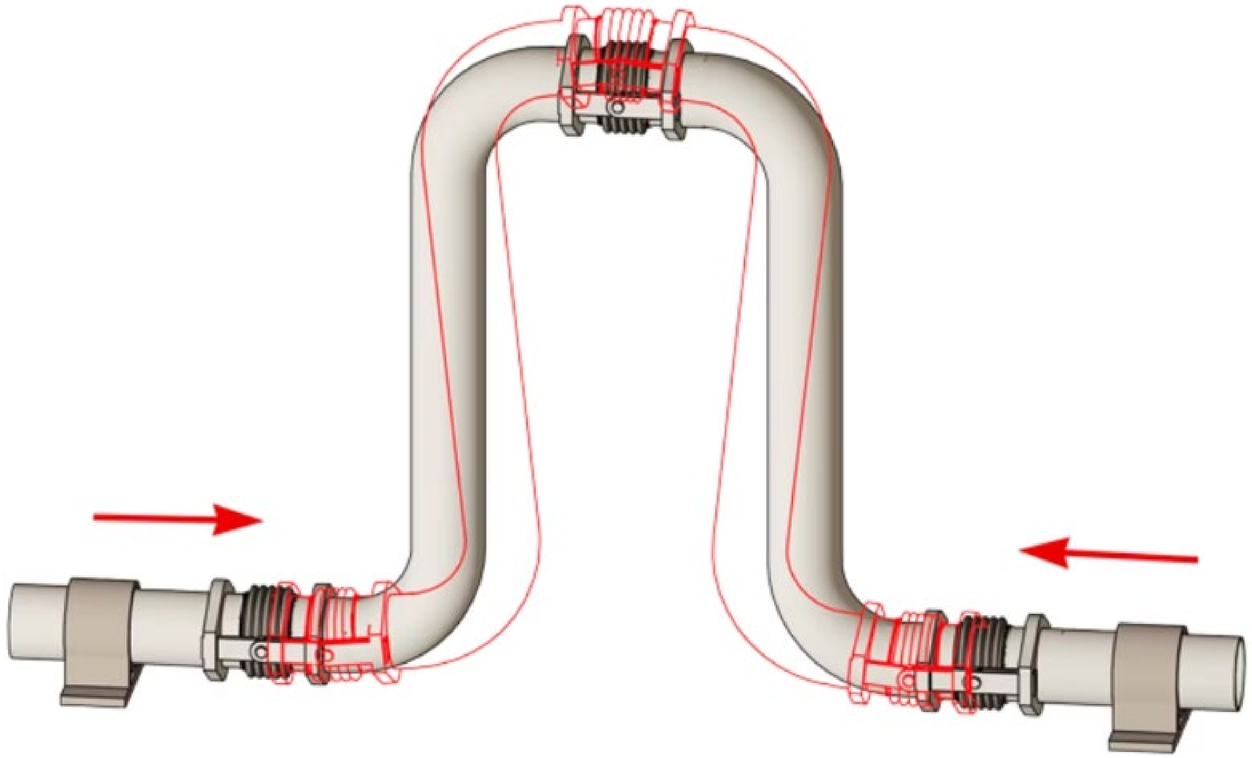
Measuring for Thermal Expansion

Expansion Calculation

Metal piping expands when heated and contracts when cooled. The amount of expansion depends on:

- Pipe material (coefficient of thermal expansion)
- Temperature change
- Length of pipe run

Formula: Expansion = Length × Coefficient × Temperature Change



Proper measurement and accommodation for thermal expansion prevents:

- Stress on pipe joints
- Damage to supports and anchors
- Potential gas leaks
- System failure

Measuring for Pressure Testing

Select Test Pressure

Determine required test pressure based on system type

Connect Test Equipment

Measure and verify gauge accuracy before testing

Monitor Test Duration

Measure test time according to code requirements

Record Results

Document pressure measurements throughout test period

Measuring for Combustion Analysis

Measuring for Regulatory Compliance

Code Requirements

Gas installations must comply with specific measurement requirements in local and national codes, including:

- Minimum clearances to combustibles
- Ventilation opening sizes
- Pipe sizing parameters
- Installation heights and distances

Documentation

Measurements must be documented for:

- Permit applications
- Inspection reports
- As-built drawings
- Maintenance records

Verification

Measurements may need to be verified by:

- Licensed inspectors
- Utility representatives
- Quality control personnel
- Regulatory authorities

Summary of Measuring Tools and Techniques

1

Basic Measurement Tools

Spring-loaded tapes, folding rules, squares, and straight edges form the foundation of measurement in gas installation work.

2

Precision Instruments

Feeler gauges, drill gauges, and drill bit blanks provide the precision needed for critical measurements.

Digital Technology

Modern digital tools enhance accuracy and efficiency in measurement tasks.

4

Specialized Equipment

Industry-specific measuring devices address the unique requirements of gas systems.

Safety Focus

Proper measurement techniques ensure the safety and compliance of gas installations.

CSA Unit 2 Chapter 5 Combustion Testing Instruments

Gas technicians and fitters use various instruments to check air quality in the working environment and to ensure safe and efficient operation of gas fired equipment. These instruments are essential for testing the combustion process and analyzing flue gases to verify safe operation and optimize combustion efficiency.

Purpose of Combustion Testing

Why Testing Matters

The gas technician/fitter uses many instruments to check air quality in the working environment and to ensure safe and efficient operation of gas fired equipment. This includes analyzing flue gases to check the efficiency of combustion and the level of toxic gases.

Learning Objectives

Identify Types of Instruments

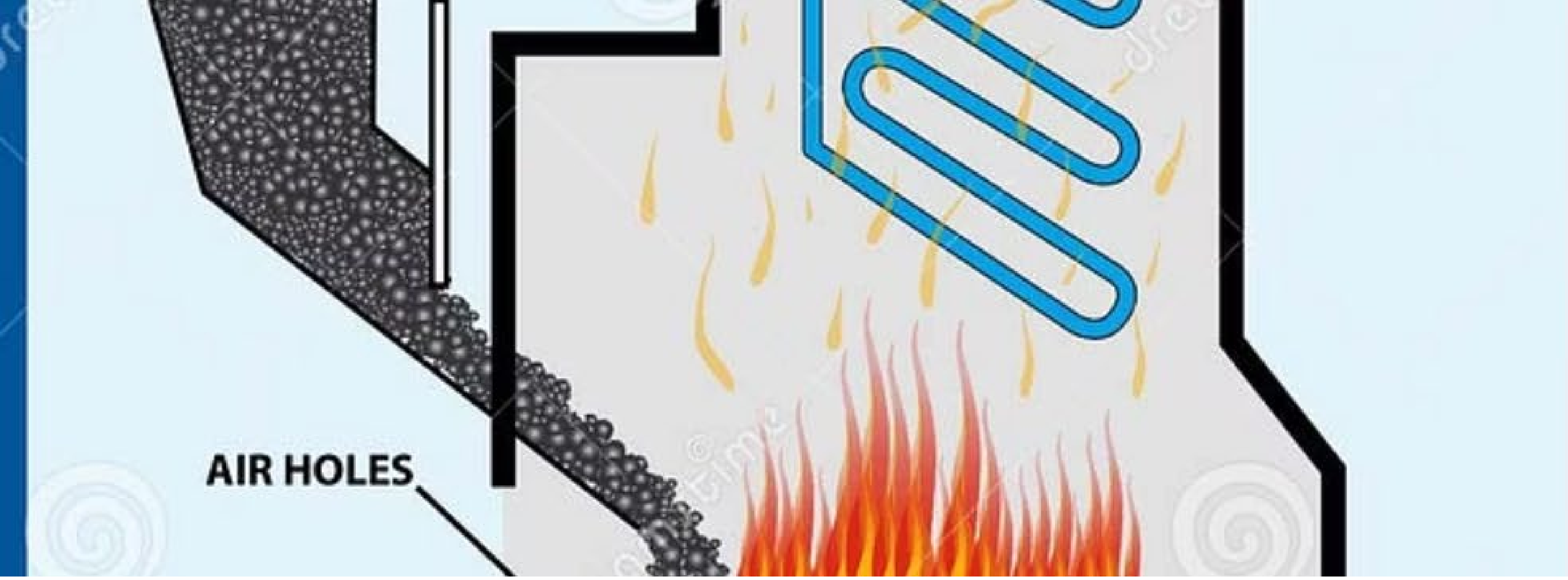
At the end of this Chapter you will be able to identify types of combustion testing instruments.

Understand Applications

You will learn how these instruments are used to test gas appliances designed for many different applications.

Ensure Safe Operation

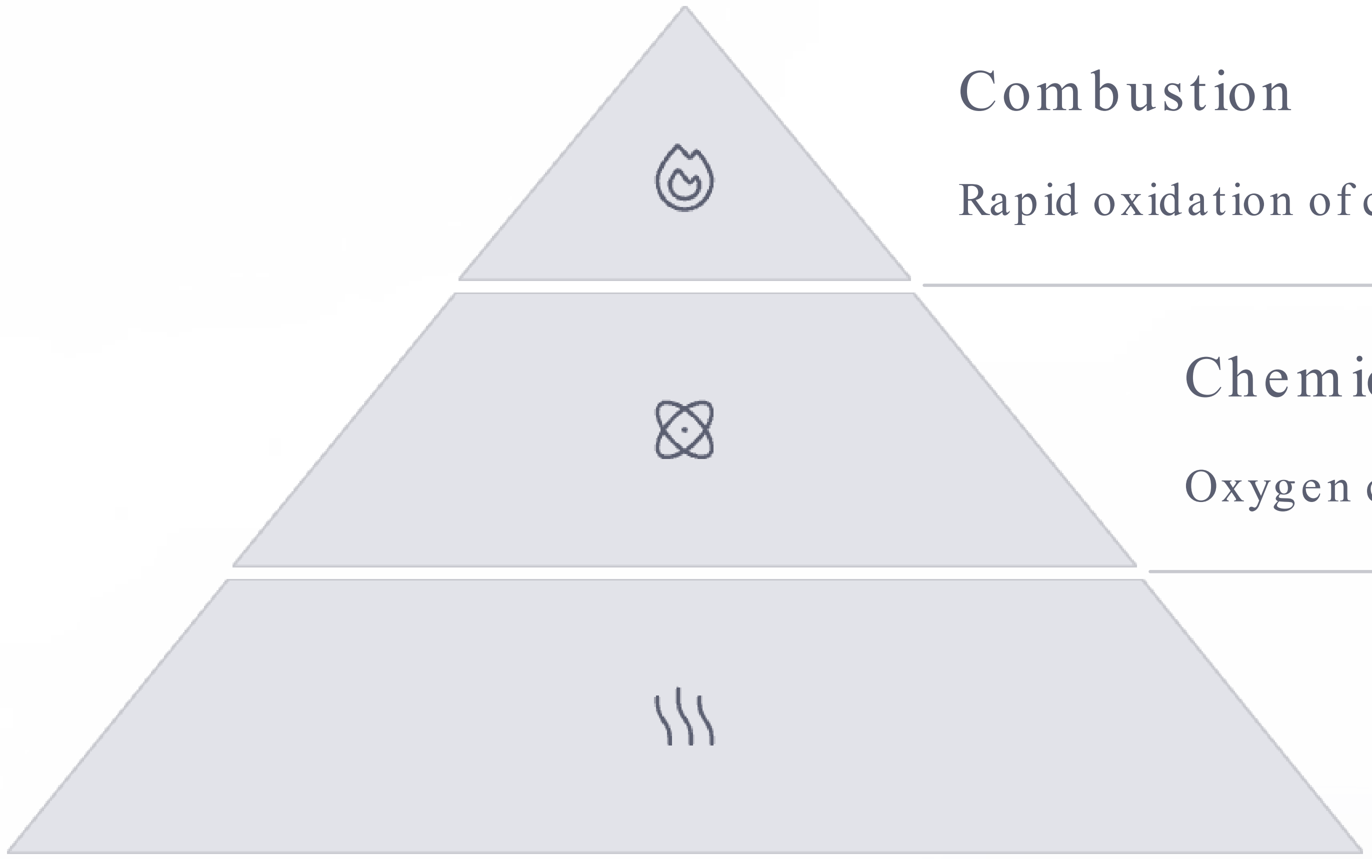
You will understand how testing helps verify safe operation of gas-fired equipment.



Key Terminology

Term	Abbreviation (symbol)	Definition
Combustion		The rapid oxidation of any material classified as a combustible matter.
Ignition temperature		Temperature at which combustion can take place.
Pound per square inch	PSI	Measure of pressure in a vessel.

Principles of Combustion



Combustion

Rapid oxidation of combustible matter

Chemical Reaction

Oxygen combines with fuel elements

Heat Energy

Released during the combustion process

Combustion is the rapid oxidation of any material classified as a combustible matter. It is a rapid chemical reaction. Familiar combustion processes include the burning of gasoline in an automobile engine and the burning of natural gas as a fuel.

The Three Elements of Combustion

Oxygen

From air, combines with combustible elements

Fuel

The combustible material that burns

Heat

Raises temperature to ignition point

During combustion, oxygen from air combines with the combustible elements of a fuel-normally carbon and hydrogen-to release heat energy. However, fuel and oxygen alone do not produce combustion. Raising the temperature to the ignition temperature at which combustion can take place also requires heat.

Removal of any one of the three elements stops combustion. For efficient combustion to take place, you must present each in the right quantity. It is important to have the right flow of air containing oxygen. There can be too much or little air to support combustion.

Flue Gases and Combustion Analysis

What Are Flue Gases?

The combustion process forms products which are usually exhausted through a flue, vent, or chimney. In the gas industry, these are called flue gases. Altering the air-gas mixture to the combustion process affects the volume of and percentage of flue gas components.

Why Analyze Flue Gas?

You must analyze flue gas to check the efficiency of combustion and the level of toxic gases.

What Is Measured?

A combustion analysis determines the completeness of combustion and what percentages of the total volume of dry flue gas are carbon dioxide (CO_2), oxygen (O_2), and carbon monoxide (CO). In certain cases, you may also measure hydrogen (H_2), nitric oxides (NO and NOx), and hydrocarbons (HC).

Types of Flue Gas Analyzers

Continuous Sampling

Electronic analyzers that provide continuous sampling through electrochemical, non-dispersive infrared tube, or selective chemical reaction methods.

Tube Analyzers

Single-use glass tubes filled with dry chemicals, such as those made by Draeger and Gastec.

Liquid Analyzers

Analyzers that use selective chemical absorption, enabling testing of many flue gas samples without changing chemicals.

Flue gas analyzers provide the gas technician/fitter and client with accurate information that they may use in adjusting appliances for optimum combustion efficiency or to verify safe operation.

Handling Flue Gas Analyzers

Follow Instructions

Always follow the manufacturers' recommendations

Proper Storage

Store instruments according to guidelines

Regular Calibration

Ensure accurate readings through calibration

Correct Usage

Use instruments as intended

Incorrect handling of flue gas analyzers can easily damage these instruments and give inaccurate readings, which can be very dangerous. To prevent these, always follow the manufacturers' recommendations for storage, handling, calibration, and use of these instruments.

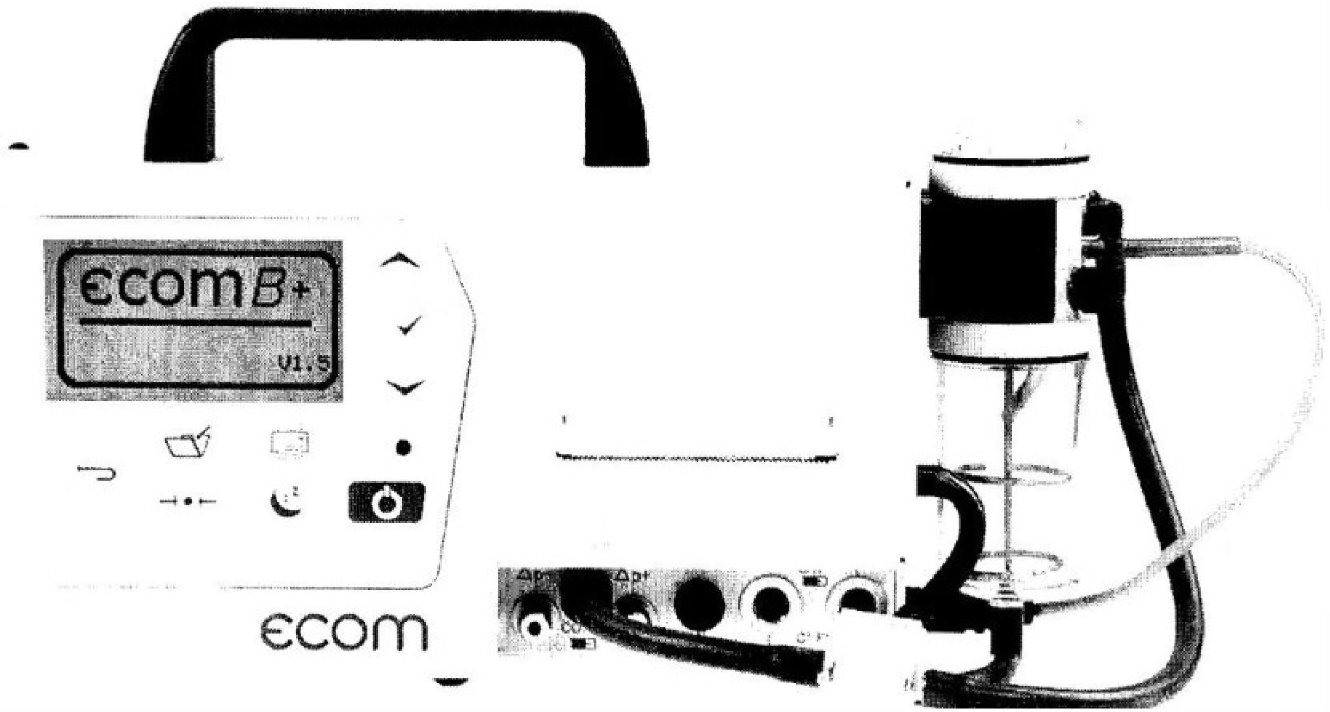
Continuous Sampling Electronic Analyzers

Features and Benefits

The most commonly used flue gas analyzers are electronic, and they come in many different makes and models. The field technician/fitter usually uses a hand-held portable device, which is versatile and not difficult to operate.

The most up-to-date analyzers measure all the products of combustion. Most analyzers have temperature probes and pressure sensors built in.

Modern flue gas analyzers can store information, download the data to a computer, and transmit the information to a printer to produce hard copy reports for the client.



Multi-gas emission analyzer

With a continuous sampling device, sensors in the Unit continuously analyzes a measured flow of flue gas sample for the device's duration of being connected to the appliance, unlike its predecessors which only manually spot sample at user-determined intervals.

Tube Analyzers

How Tube Analyzers Work

The least expensive flue gas analyzer uses pencil-shaped glass tubes filled with dry chemicals. Each tube contains a different chemical, and each one's function is to test for a specific type of gas. Usually, the tubes are single-use.

Each detector tube contains precise amounts of detecting reagents in a glass tube with a fixed inner diameter. The tube is hermetically sealed at both ends to protect the contents until they are exposed to the flue gas during testing. Draeger and Gastec are two well-known manufacturers of this type of equipment.

Gastec tube type flue gas analyzer system

Using Gastec Detector Tubes

Break Tube Ends

To start the test, break off the tapered tube ends and connect one opened end of the tube to the Gastec sampling pump.

Draw Sample

Pull the hand operated vacuum pump handle to draw the flue gas sample through the tube. The pump, which may draw a fixed amount or be adjusted for different tests, measures the volume of gas drawn.

Observe Reaction

As the sample moves through the tube, the test gas reacts immediately with the dry chemical and causes it to discolour, beginning at the entry end of the detector tube. The higher the concentration of test gas present, the greater the length of dry chemical discoloring.

Read Results

Measure the gas concentration at the point where the coloration stops. Graduated markings on the side of the tube make it easy to read the precise percentage of the test gas found in the sample.

Liquid Analyzers

Advantages

The advantage of liquid over tube analyzers is that they enable you to test many flue gas samples without the need to change the chemicals. This is particularly useful when you must analyze several samples during the set up of a burner system.

Common Gases Measured

The two most common gases measured with liquid flue gas analyzers are CO_2 and O_2. The reagent (reacting chemical) for measuring CO_2 is potassium hydroxide (dyed red) and for measuring O_2 is chromous chloride (blue).

Longevity

You can use the potassium hydroxide for approximately 400 tests before requiring replacement, and the chromous chloride for approximately 200 tests prior to replacement.

A common liquid test Unit is the Fyrite system which uses the "Orsat Method".

How Liquid Analyzers Work

Fill with Reagent

Each individual test Unit is partially filled with the specific reagent to test a particular component of the fuel gas, CO_2 or O_2.

Chemical Absorption

As the chemical in the test Unit absorbs the flue gas, the volume of the fluid either expands or contracts and is measured on a scale on the side of the tube.

Reset for Next Test

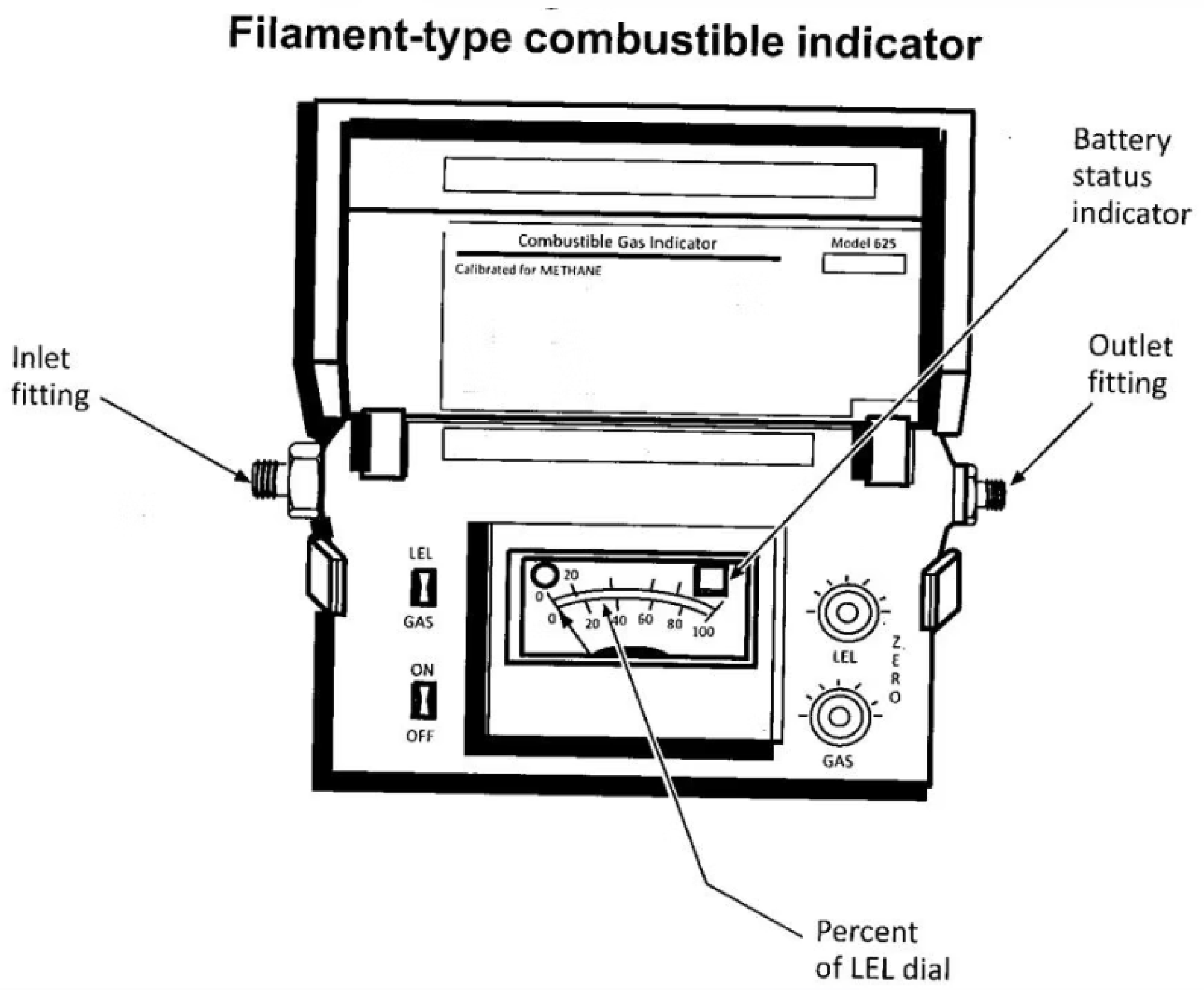
After the analysis of the flue gas sample, the test Unit is vented, leaving it ready for the next sample.

Combustible Gas Indicators

Purpose and Function

Gas technicians/fitters use combustible gas indicators to test for combustible gases in surroundings. Attaching a sampling probe can be useful for difficult-to-access areas. Digital or analogue types are available.

These instruments are covered in greater detail in Unit 3 Properties, Characteristics, and Safe Handling of Fuel Gases.



Combustible gas indicator (solid-state)

Pressure and Temperature Measurement

Pressure

When an object exerts a force over an area of another object, it exerts pressure. Pressure is the force exerted per Unit area.

Temperature

Temperature (i.e., the degree of heat) is measured using various scales such as Fahrenheit and Celsius. These scales have fixed points used for comparison and are based on such things as the boiling and freezing points of water at a particular pressure.

Gas technicians/fitters use various gauges to measure gas pressure and temperature to ensure safe and efficient operation of gas appliances.

Types of Pressure Gauges

Pressure Gauges

Measure the force per Unit area exerted by a confined gas. They measure pressures above atmospheric.

Vacuum Gauges

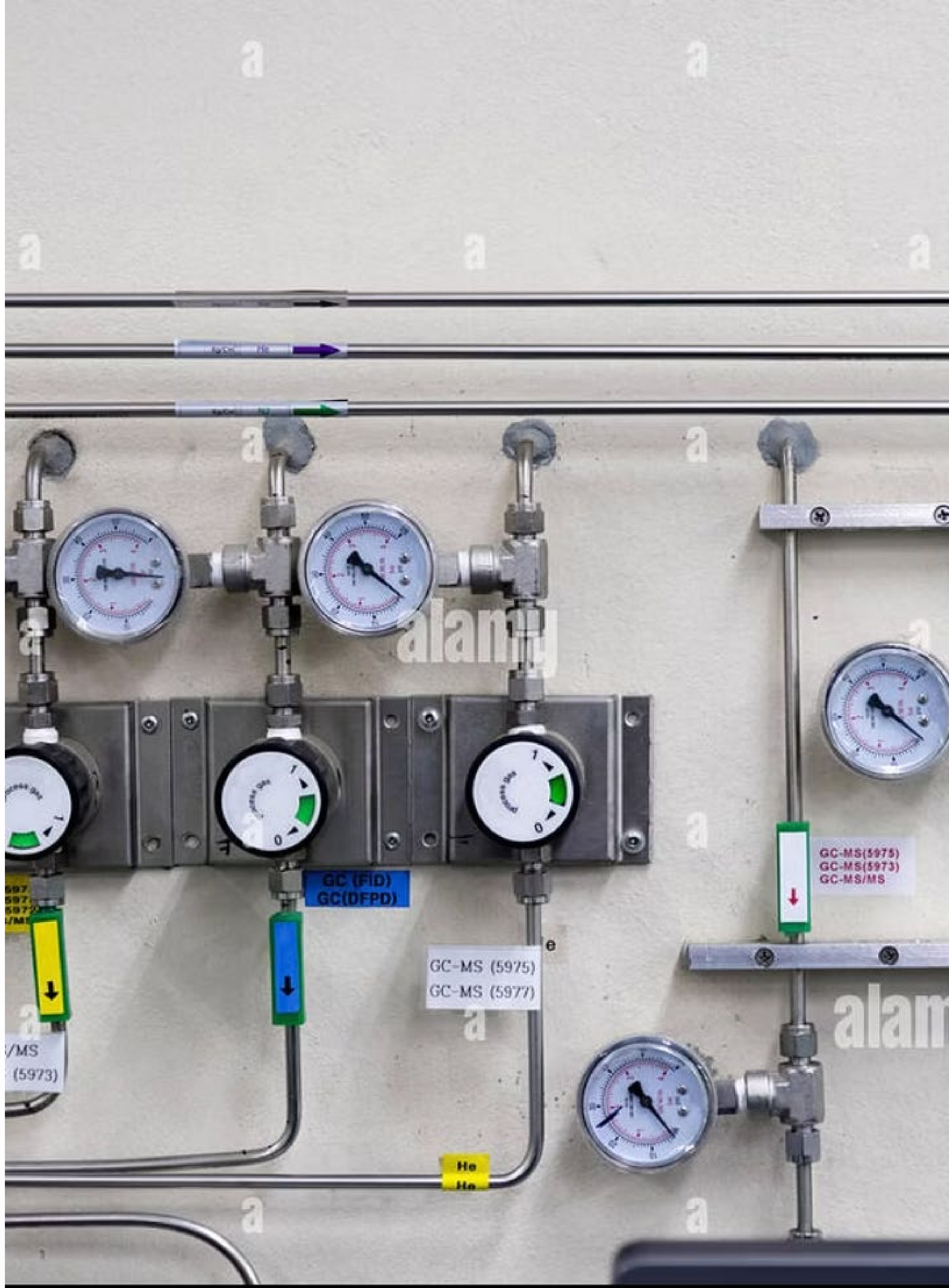
Measure pressures below atmospheric.

Compound Gauges

Measure pressures both above and below atmospheric.

Draft Gauges

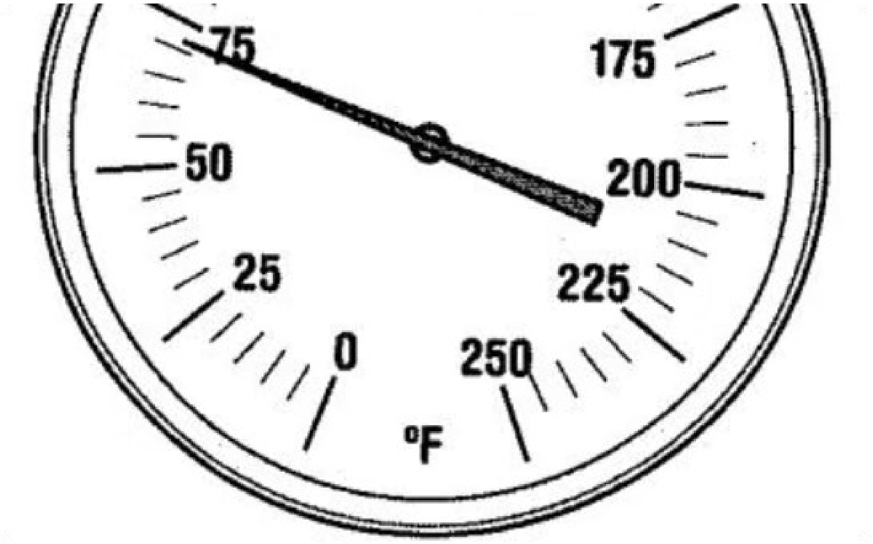
Measure the gas density of low gas heads or small differential gas pressures.



Types of Temperature Gauges

Analog Temperature Gauges

Measure sensible heat changes. Sensible heat is a change in temperature which you can feel. Latent heat causes a change in state without changing temperature.



Digital Temperature Gauges

Are the most common for technicians/fitters to use. Their only disadvantage is the need for battery power.

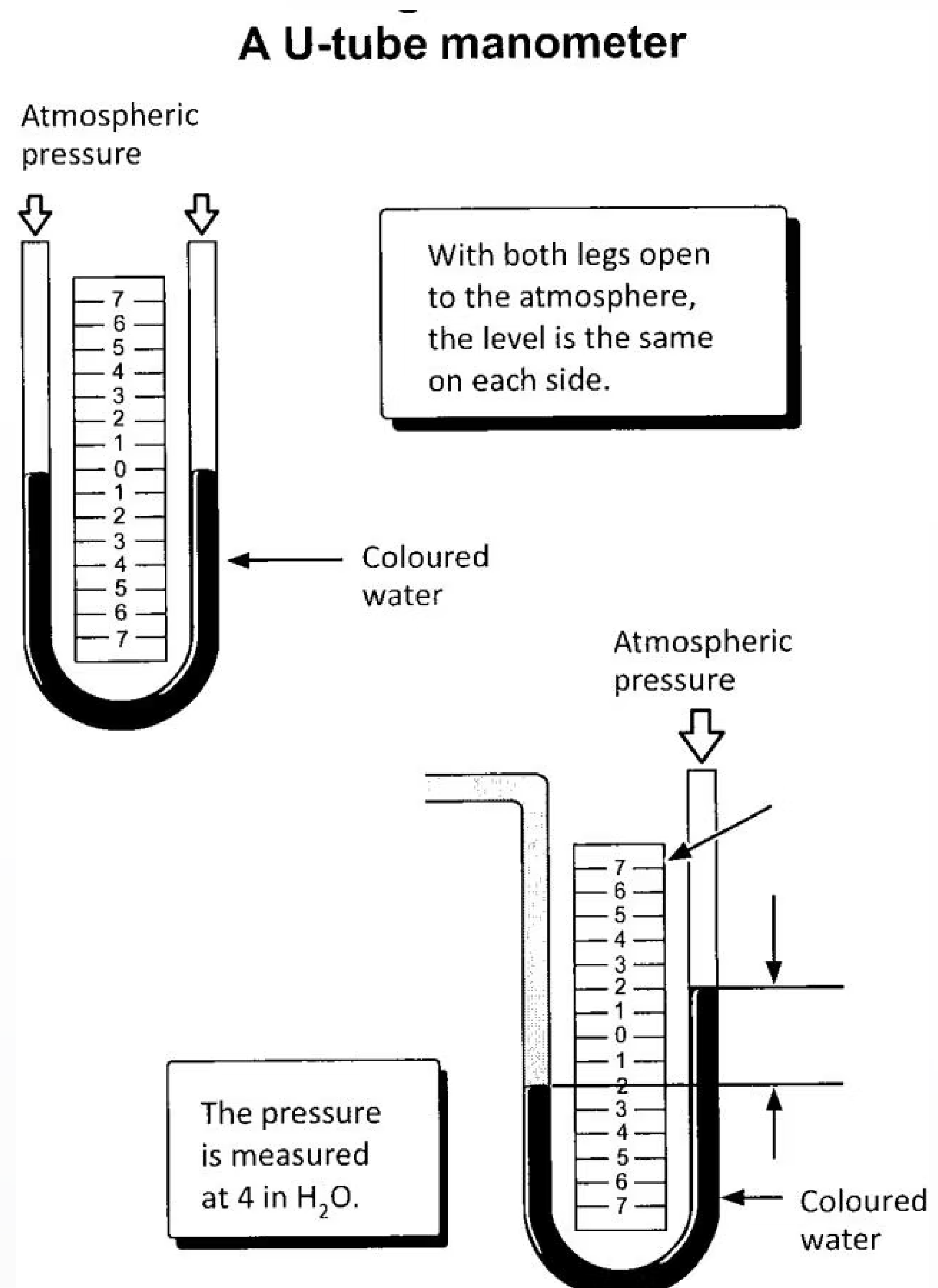
Plug-in Sensors

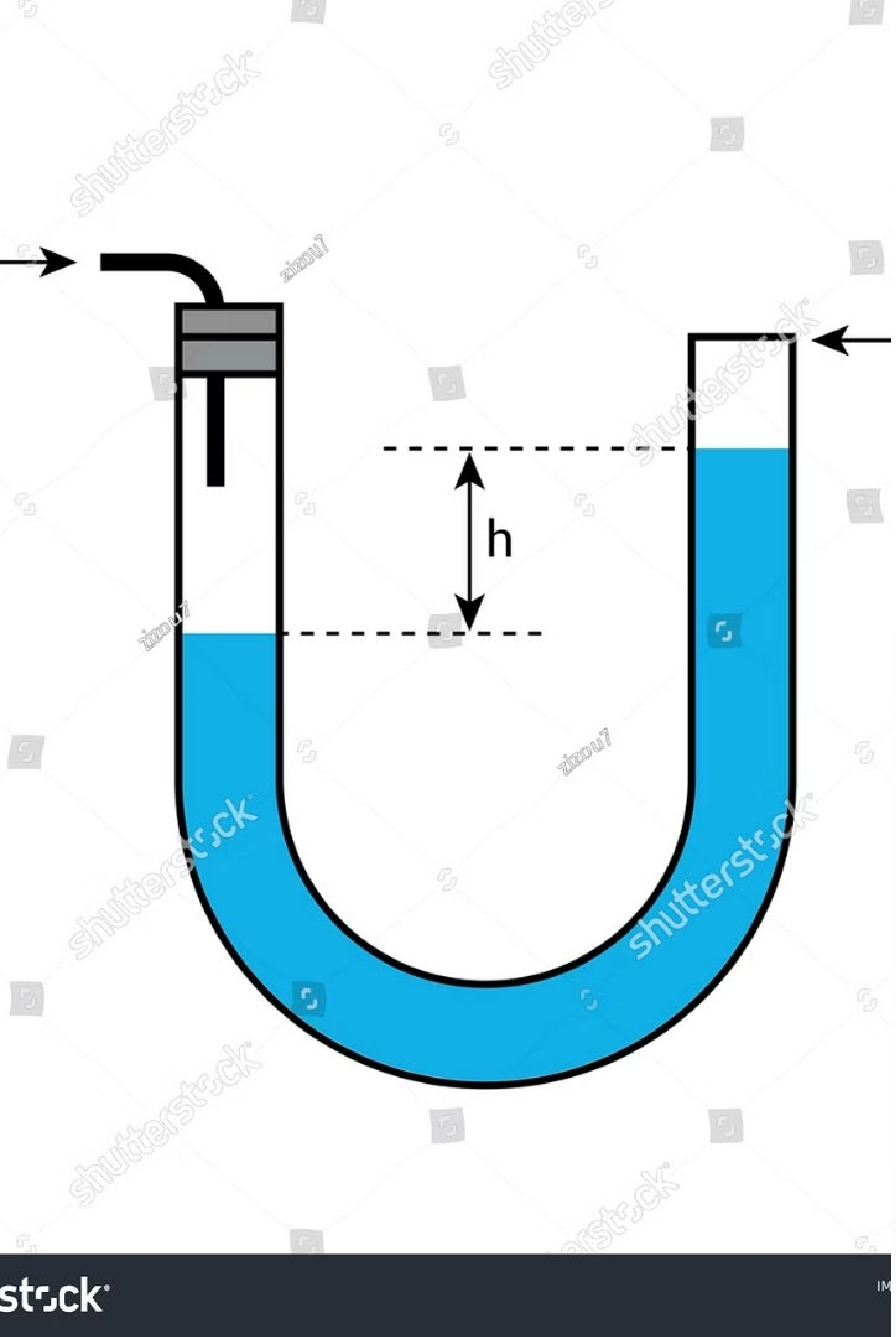
The type of hand-held thermometer shown uses plug-in sensors in a variety of types, sizes, and styles.

Manometers

What is a Manometer?

The manometer is a U-shaped tube that helps measure the difference in pressure between the tops of the liquid in the two sides of the liquid is water or coloured gauge oil. Small positive or negative pressures are expressed in inches of water column; 1PSI is equal to 27.7 inches of water column. Gas technicians/fitters most often use the water column measurement.





How a Water-Filled U-Tube Manometer Works

Zero Pressure Reading

When both legs of the tube are open, only atmospheric pressure acts on the surface of the liquid. This gives the same liquid level in each leg. The gauge pressure then reads zero.

Pressure Differential

When one leg is connected to a source with pressure higher (or lower) than atmospheric, the additional (reduced) pressure causes the liquid to move, lifting (displacing) the column in the leg that is open to the atmosphere.

Measurement

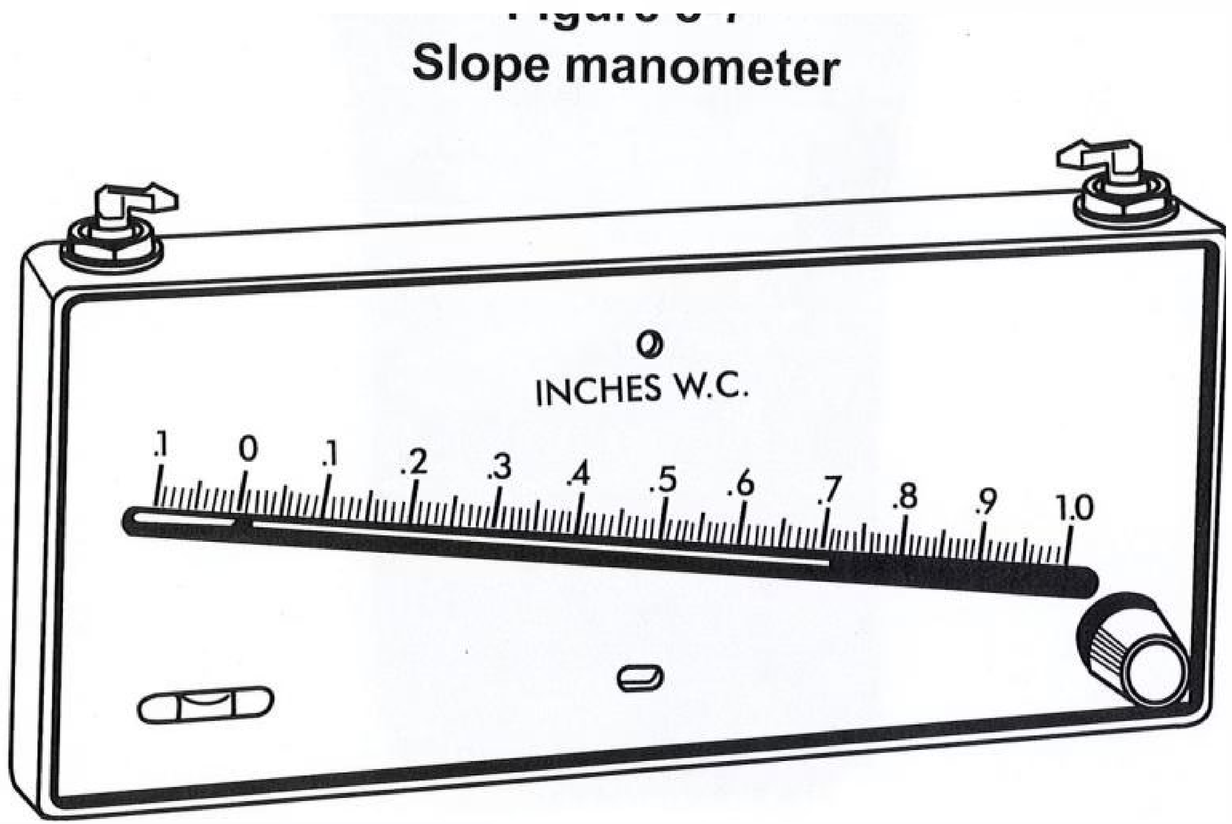
The difference between the liquid heights in the two legs determines the gauge pressure of the pressurized source.

Slope Manometers

Design and Function

Slope manometers are also called inclined-vertical manometers. In this type, the arm of the manometer in which liquid level varies is gradually sloped rather than vertical.

Typically, a slope manometer is about 20 in (500 mm) long. This enables the accurate observation of extremely small incremental changes. Normally, these devices are permanently mounted on equipment.



Slope manometer showing gradual incline for precise measurements

Digital Manometers

Features and Applications

Electronic manometers are the most common field service tool that measures positive and negative pressures. They are available in a variety of models showing different ranges and may have many other features.

You can use digital manometers as draft gauges, if equipped with the correct range, and to measure differential pressures.

Traditional Temperature Gauges

Analog Thermometers

Sometimes referred to as thermometers, temperature gauges come in many different styles and types. In their traditional form, thermometers are a scale displaying temperature Units of measurement, (i.e., degrees Fahrenheit).

Figure 5-9
(top) Bimetal dial thermometer, (bottom) Spirit-filled thermometer

Traditional analog thermometer with temperature scale

Digital Thermometers

Modern Temperature Measurement

As with most other instruments, many electronic options are now available. Digital thermometers are the most popular temperature measuring tool used today. Their only disadvantage is the need for battery power.

Digital hand-held thermometer with plug-in sensors

Importance of Proper Instrument Selection

Assess Requirements

Determine what needs to be measured

Select Instrument

Choose appropriate testing equipment

Analyze Results

Interpret readings and take action

Perform Testing

Use instrument according to guidelines

Selecting the right instrument for the job is crucial for accurate measurements and safe operation of gas appliances. Gas technicians must understand the capabilities and limitations of each instrument type.

Ensuring Accurate Measurements

1

Read Instructions

Understand instrument operation

Calibrate Regularly

Maintain accuracy of readings

Proper Maintenance

Keep instruments in good condition

Ongoing Training

Stay updated on new technologies

Safety Considerations When Testing

Personal Protection

Always wear appropriate personal protective equipment when working with gas systems and testing instruments.

Ventilation

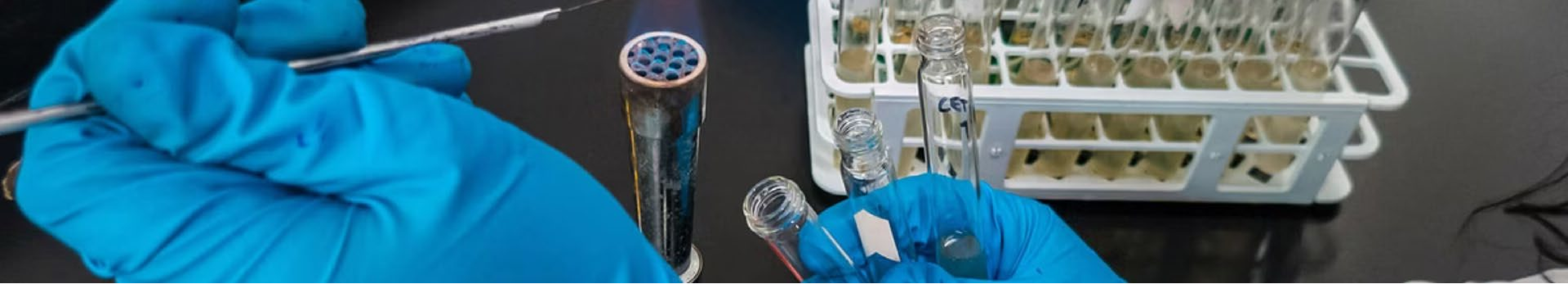
Ensure adequate ventilation when testing combustion processes to prevent buildup of harmful gases.

Instrument Integrity

Regularly check testing instruments for damage or wear that could affect accuracy or safety.

Follow Procedures

Always follow established testing procedures and manufacturer guidelines for both the equipment being tested and the testing instruments.



Interpreting Test Results

3

Key Elements

Fuel, oxygen, and heat are the three essential elements for combustion

27.7

Water Column

Inches of water column equivalent to 1 PSI

400

Test Capacity

Number of tests possible with potassium hydroxide before replacement

Understanding the numerical values and relationships between different measurements is essential for proper interpretation of combustion test results. Gas technicians must be able to recognize when readings fall outside acceptable parameters and take appropriate action.

Technological Advancements in Testing

Traditional Instruments

Manual gauges and liquid-based analyzers requiring visual interpretation

Digital Revolution

Electronic instruments with digital displays for more precise readings

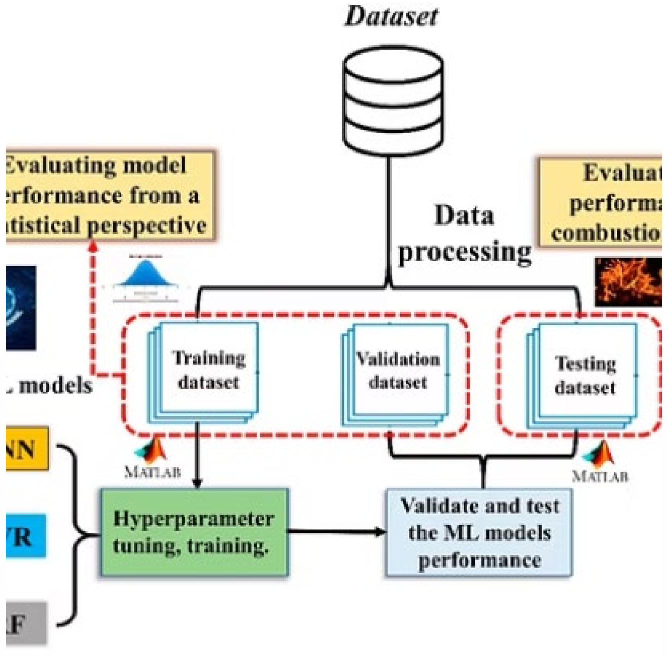
Data Storage

Modern analyzers with ability to store and download test data

Wireless Connectivity

Latest instruments featuring wireless transmission of results to computers and mobile devices

The Future of Combustion Testing



The field of combustion testing continues to evolve with new technologies emerging. Smart devices with enhanced connectivity, artificial intelligence for predictive analysis, augmented reality interfaces, and increasingly miniaturized yet powerful instruments are shaping the future of how gas technicians will ensure safe and efficient operation of gas-fired equipment.

CSA Unit 2

Chapter 6 Electrical Testing Instruments

This presentation covers the various electrical testing instruments used by gas technicians and fitters. We'll explore their purposes, proper handling, and storage requirements to ensure accurate measurements and safe operation.

Purpose and Objectives

Purpose

The gas technician/fitter must use various electrical testing instruments. This Chapter identifies them and describes the basic ways to handle and store them.

Objectives

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

- describe the purposes of electrical testing instruments
- describe storage and handling requirements of electrical testing instruments

Key Terminology

Term	Abbreviation (symbol)	Definition
Amperes	A	Flow rates of electric charge
Milliamperes	mA	One-thousandth of an ampere
Microamperes	uA	One-millionth of an ampere
Ohms	Ω	Measurements of resistance

ELECTRICAL METRIC CONVERSION CHART

MULTIPLY	BY	TO OBTAIN / MULTIPLY	BY	OBTAIN
Centimeters (cm)	0.3937	Inches (in)	2.54	Centimeters (cm)
Meters (m)	3.2808	Feet (ft)	0.3048	Meters (m)
Meters (m)	39.37	Inches (in)	0.0254	Meters (m)
Square Meters (m^2)	10.76	Square Feet (sq. ft.)	0.0929	Square Meters (m^2)
Cubic Meters (m^2)	35.314	Cubic Feet (c.f)	0.0283	Cubic Meters (m^2)
Kilograms (kg)	2.205	Pound (lb)	0.4536	Kilograms (kg)
Liters per second (i/s)	2.12	Cubic Feet Per Minute (cfm)	0.472	Liters per second (i/s)
RSI	5.679	R	0.176	RSI
RSI/mm	144	R/n	0.00695	RSI/mm
$/RSI/$m^2$	1.64	¢/R/ft2	0.611	$/RSI/$m^2$

Conversion of Units of Electric Charge

FROM/TO	CONVERSION FACTOR
Coulomb (C) to Microcoulomb (μC)	1 C = 1,000,000,000 nC
Coulomb (C) to Nanocoulomb (nC)	1 C = 1,000,000,000 nC
Coulomb (C) to Picocoulomb (pC)	1 C = 1,000,000,000,000 pC
Coulomb (C) to Abcoulomb (abC)	1 C = 0.1 abC
Coulomb (C) to Franklin (Fr)	1 C ≈ 3.33564 × 10^9 Fr
Coulomb (C) to Faraday (F)	1 C ≈ 0.0000104 F
Microcoulomb (μC) to Coulomb (C)	1 μC = 10^-6 C
Nanocoulomb (nC) to Coulomb (C)	1 nC = 10^-9 C
Picocoulomb (pC) to Coulomb (C)	1 pC = 10^-12 C
Abcoulomb (abC) to Coulomb (C)	1 abC = 10 C
Franklin (Fr) to Coulomb (C)	1 Fr ≈ 3.33564 × 10^-10 C
Faraday (F) to Coulomb (C)	1 F ≈ 96,485.34 C

Additional Terminology

Term	Abbreviation (symbol)	Definition
Kilohms	kΩ	Resistance
Resistance	-	The ability of a substance to resist the flow of current
Volts	V	Measures of electric potential
Millivolts	mV	One-thousandth of a volt
Volts direct current	Vdc	Measure of electric potential in a direct current circuit
Volts alternating current	Vac	Measure of electric potential in an alternating current circuit

Manometer Pressure Reading Exercise 1

Question

Select the correct manometer pressure reading for the following figure?

Options

- a) 7 inches w.c.
- b) 4 inches w.c.
- c) 10 inches w.c.
- d) 12 inches w.c.

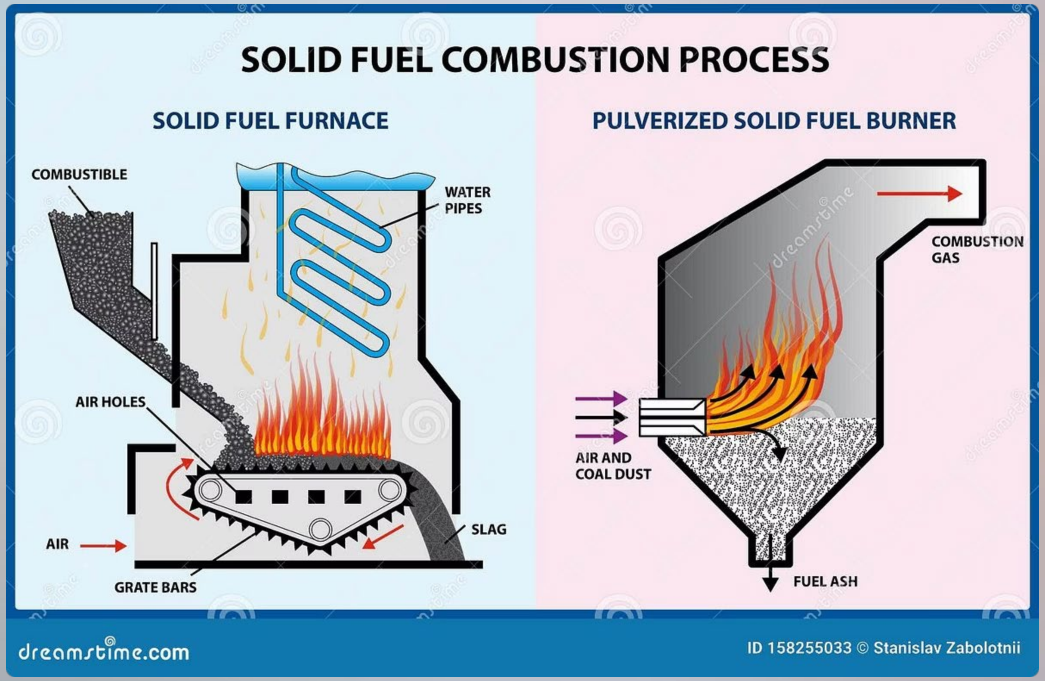
Manometer Pressure Reading Exercise 2

Question

Select the correct manometer pressure reading for the following figure?

Options

- a) 6 inches w.c.
- b) 5 inches w.c.
- c) 3 inches w.c.
- d) 7 inches w.c.



Combustion Knowledge Check

Question

Correctly complete the following sentence with the appropriate word provided: Combustion is a rapid __________ combustible elements of a fuel to release heat energy.

Options

a) Liquid

b) Heat

c) Chemical

d) Oxygen

Temperature Measuring Devices

Question

Which of the following is not a temperature measuring device?

Options

a) Dial thermometer bimetal

b) Slope thermometer

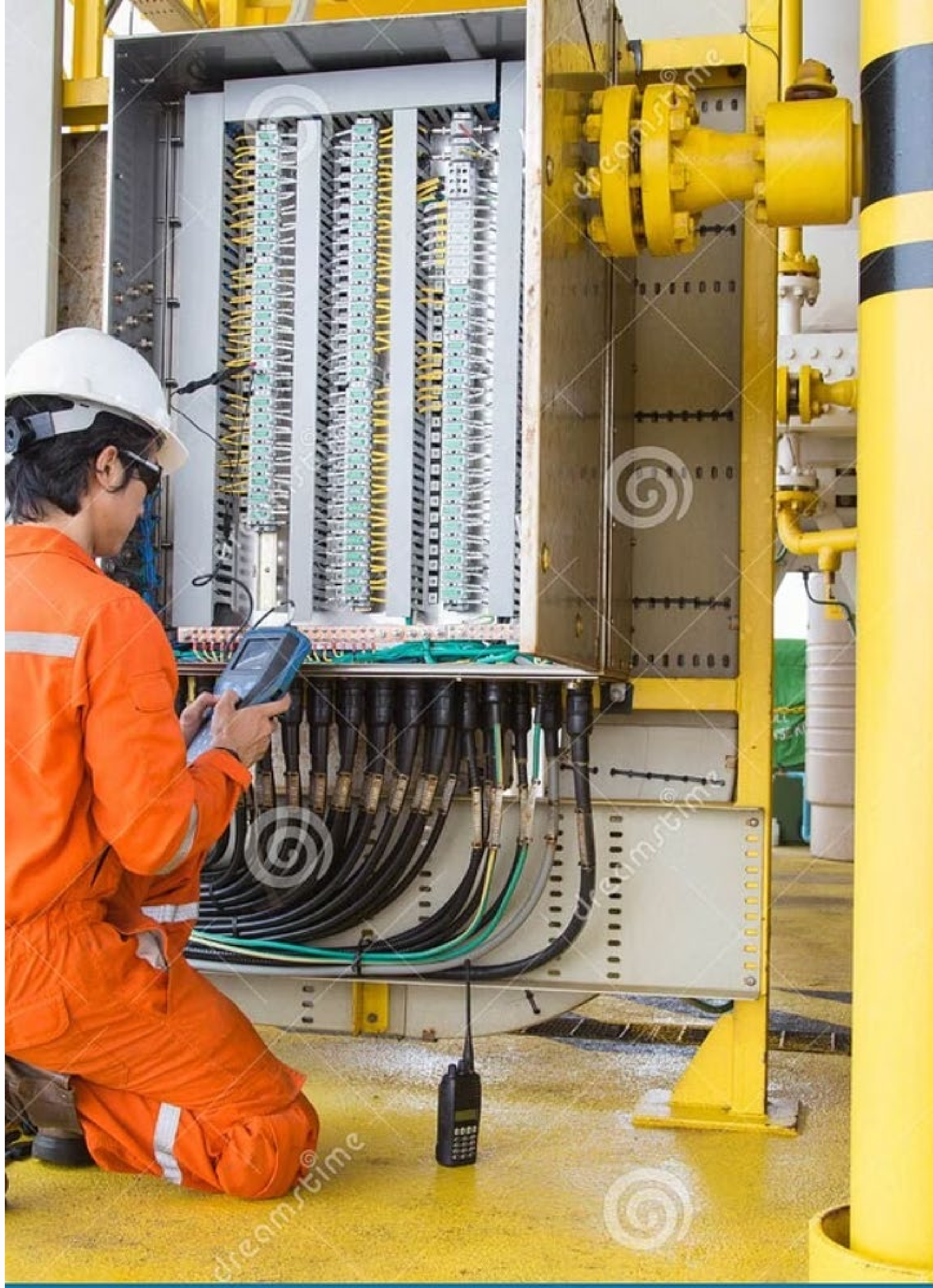
c) Spirit-filled thermometer

d) Digital thermometers employing thermocouples or infrared technology

Purposes of Electrical Testing Instruments

This section enables the gas technician/fitter to recognize various electrical testing instruments and the purpose they serve. Unit 5 Introduction to Electricity provides specific information in greater detail.

The testing instruments a gas technician/fitter may encounter while working on electrical equipment will either be permanent or hand-held and portable.



Common Electrical Instruments

Voltage Meters

Alternating current (ac) or direct current (dc) voltage meters or combinations of the two

Amperage Meters

Used to read current

Ohmmeters

Used to read resistance

Multimeters

Combine the functions of the meters above, and can be used to measure small values of voltages and amperages, among others

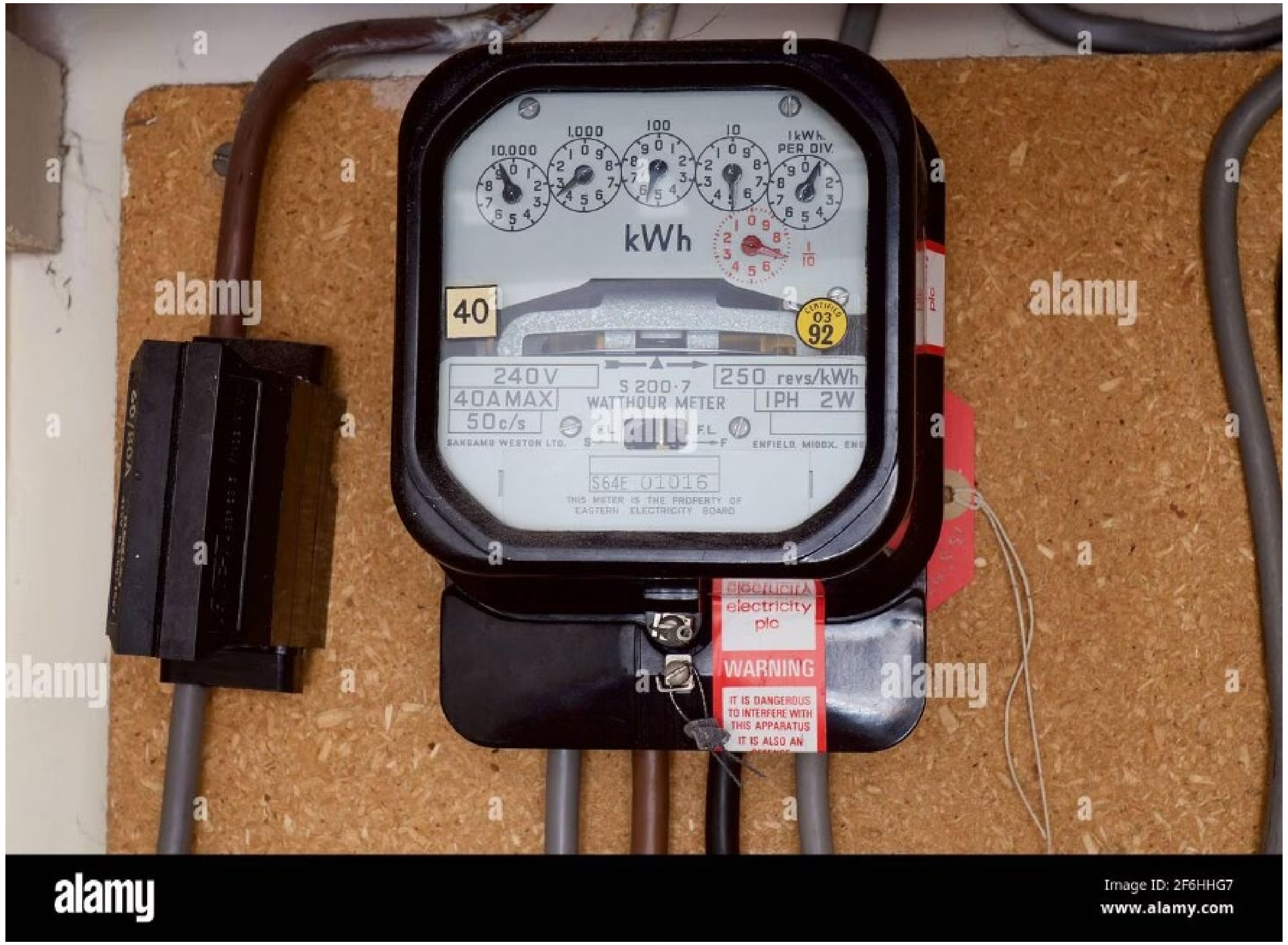
Power Meters

Used to measure wattage and usage

Types of Electrical Meters

Analogue Meters

Have a scale and pointer. The pointer's movement is directly and continuously related to the measured quantity.



Digital Meters

Interpret the measured quantity electronically in discrete numerical data (digits).

Voltmeters and Millivoltmeters

Definition

Electrical potential and voltage are measured in volts (V) or millivolts (mV).

Voltmeters measure the difference of electric potential between two points in a circuit. In the field, a multimeter is more commonly used.

Operation

An analogue voltmeter operates without batteries. It draws a very small current from the measured circuit. This current drives a pivoted coil to which the pointer is attached. The scale is marked in volts or millivolts.

Ammeters and Microammeters

Definition

The size of an electric current flow is measured in amperes (A), milliamperes (mA), or microamperes (μA).

Ammeters measure the current flowing through a circuit. In the field, a clamp on multimeter is more commonly used.

Operation

An analogue ammeter operates without batteries. It is inserted into the circuit so that the full current being measured flows through the instrument. The current drives a pivoted coil to which the pointer is attached. The scale is marked in amperes, milliamperes, or microamperes.

Ohmmeters

Definition

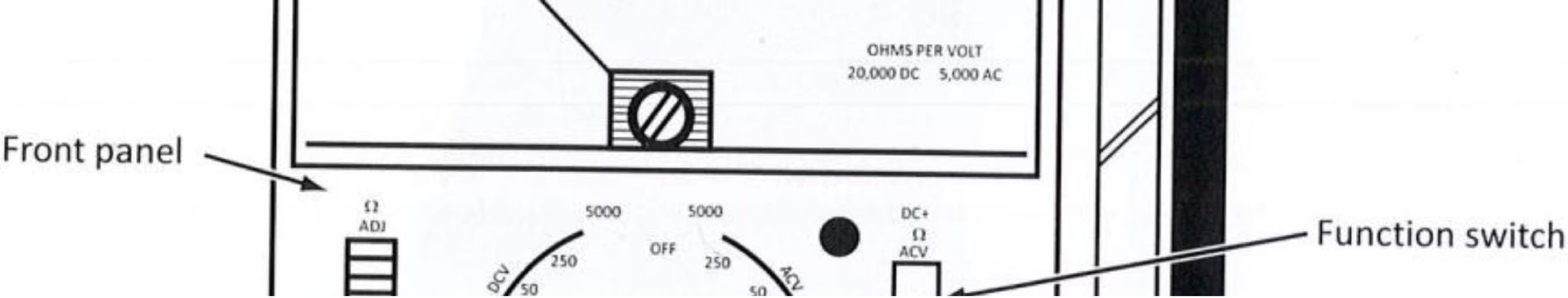
The ability of a substance to resist the flow of current is called resistance and is measured in ohms (Ω) or kilohms (kΩ).

You can use an ohmmeter to measure both resistance and continuity of a circuit. (An open circuit represents an infinitely large resistance to current flow.) It is easily distinguished from an ammeter or voltmeter because its scale reads from right to left. In the field, a multimeter is more commonly used.

Operation

A flashlight type of battery powers the ohmmeter. This drives current through the tested circuit's resistance. This current drives a pivoted coil to which the pointer is attached. Although current is being measured, the scale is marked in ohms.

It is important to set the zero for each measurement. This action also tests the battery. It is also important to switch off the ohmmeter when you finish measuring, so that the battery is not drained.



Multimeters

A multimeter is essentially an ammeter, voltmeter combined in a single portable case. It has two advantages: it is easier to carry and less expensive than several single-function meters.

Function Switch

Sets the meter to measure ac, dc, or resistance

Range Switch

Selects the correct range for the voltage, current, or resistance being tested

Zero-Ohms Adjustment

Compensates for variations in the internal battery voltage of the meter

Additional Features

Zero adjustment for the pointer, reset button, and several jacks for connecting circuit leads

Digital Multimeter (DMM)

A DMM has all the functions of an analogue multimeter plus advanced features. The primary difference to the technician/fitter is the way the user reads the data. DMMs have extended features depending on the make and model; Unit 5 Introduction to Electricity discusses this in more detail.

The most common multimeter used today is the digital multimeter (DMM). It usually has multiple or auto ranges of use.

Storage and Handling Requirements

The gas technician/fitter uses many varied tools. Some are simple and inexpensive, but others are complex, sensitive, and expensive. For the most part, electrical test instruments fall into the second category.

If you roughly handle or improperly use these instruments, they could be easily damaged. This will render them useless for accurate measurement, which could be dangerous.

Proper Care of Instruments - Do's

Proper Storage

Store instruments in their cases when they are not in use

Battery Management

Remove batteries if you must store the instruments for long periods

Regular Inspection

Check the battery compartment from time to time to ensure that no corrosion is taking place due to leaking batteries

Spare Batteries

Keep a spare set of batteries for digital instruments. Unlike some analogue instruments, they will not function without batteries

Proper Care of Instruments - Don'ts

Avoid Moisture

Do not allow instruments to become damp

Avoid Extreme Conditions

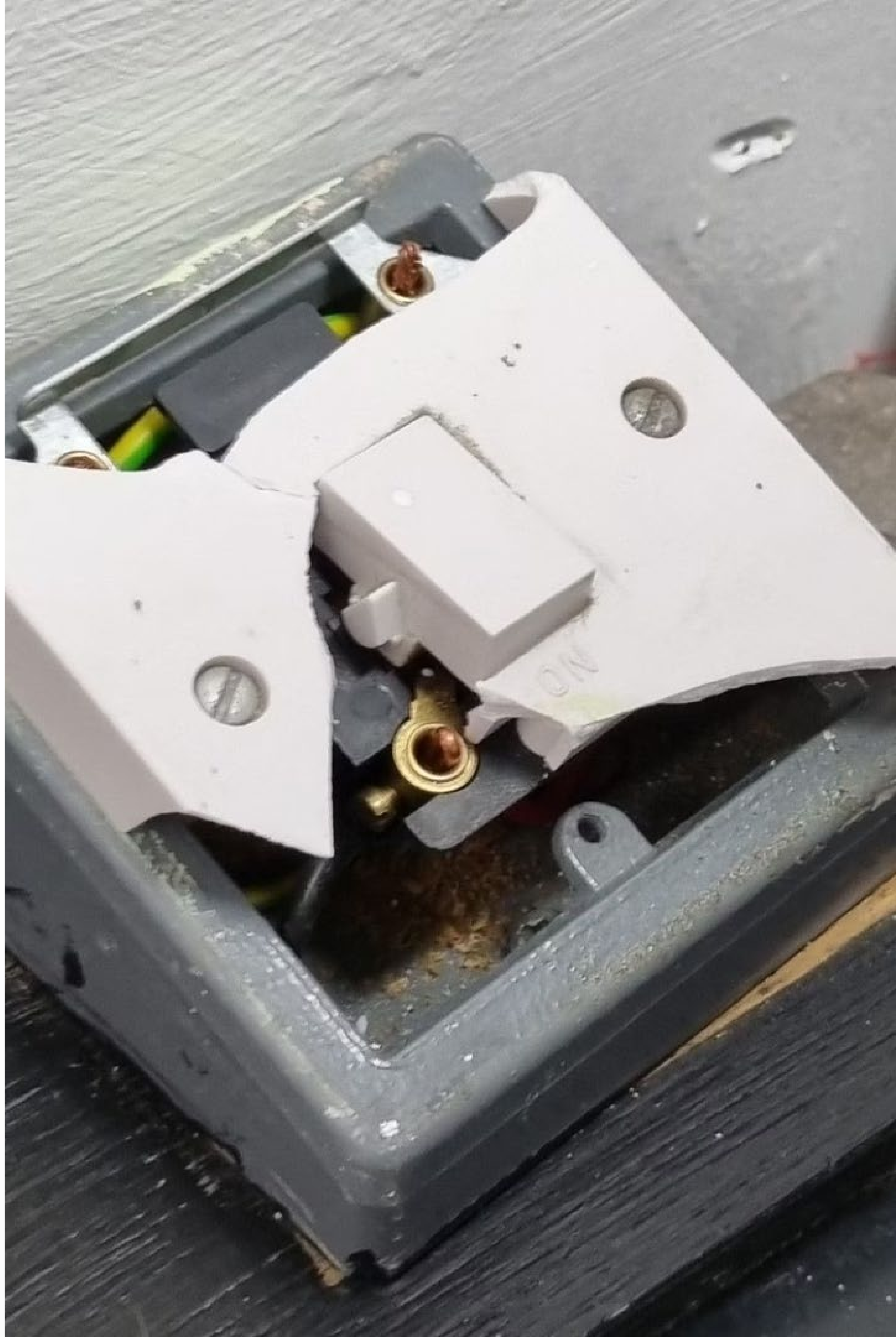
Do not expose instruments to high temperatures and humidity

Prevent Test Lead Damage

Do not store test-leads so that they become damaged - torn insulation, for example, could result in electrocution

Prevent Physical Damage

Do not allow instruments to bounce about in the back of a vehicle



Analogue vs Digital Instruments

Analogue Instruments

Analogue instruments are more delicate than digital instruments—they have moving parts on jeweled bearings and can get out of alignment if badly mistreated. Despite this, they are designed for use in the field and have been around for much longer than digital instruments.

Be careful with analogue instruments- do not, for example, allow them to bounce about in the back of a vehicle.

Digital Instruments

Digital instruments are generally more robust than their analogue counterparts. They have fewer moving parts and are less susceptible to mechanical damage.

However, they rely completely on battery power to function, so proper battery management is essential for reliable operation.

Importance of Proper Instrument Handling

Measurement Accuracy

Proper handling ensures instruments maintain their calibration and provide accurate readings

Safety

Well-maintained instruments reduce the risk of electrical accidents and hazards

Reliability

Properly maintained instruments provide consistent performance when needed

Extended Lifespan

Careful handling and storage extends the useful life of expensive instruments

Selecting the Right Instrument for the Job

Identify the measurement needed

Determine whether you need to measure voltage, current, resistance, or other parameters

Consider the measurement range

Select an instrument with an appropriate range for the expected values

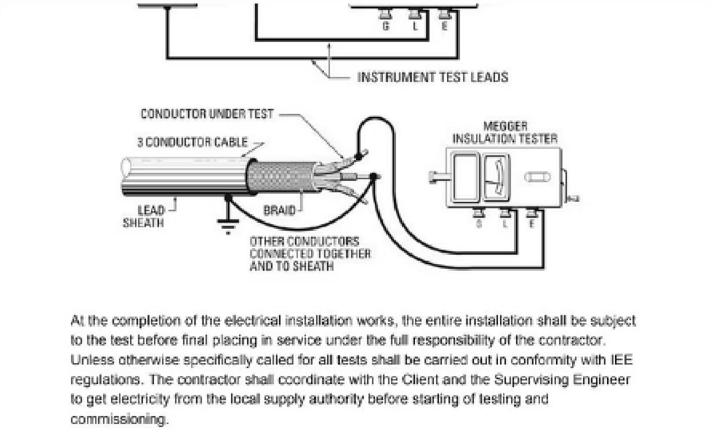
Evaluate the working environment

Consider factors like moisture, temperature, and accessibility

Verify instrument condition

Check for damage, battery level, and proper calibration before use

Common Applications in Gas Industry



Furnace Control Testing

Testing voltage and continuity in gas furnace control circuits to diagnose ignition and safety control issues

Gas Valve Verification

Measuring resistance and voltage at gas valve solenoids to verify proper operation

Thermostat Troubleshooting

Checking continuity and voltage at thermostats to ensure proper communication with heating equipment

Safety Considerations

Proper Training

Ensure you understand how to use each instrument correctly

Pre-Use Inspection

Check for damage to instruments and test leads before each use

3

Voltage Awareness

Always verify circuits are de-energized when appropriate

apper

Personal Protective Equipment

Use appropriate PPE when working with electrical equipment

Summary of Key Points

1. ## Instrument Types

Gas technicians use voltmeters, ammeters, ohmmeters, multimeters, and power meters for various electrical measurements

2. ## Proper Storage

Store instruments in their cases, remove batteries for long-term storage, and protect from moisture and extreme conditions

3. ## Handling Requirements

Handle with care to maintain accuracy and prevent damage, especially with analogue instruments that have delicate moving parts

4. ## Safety Considerations

Properly maintained instruments are essential for accurate measurements and safe operation when working with gas equipment