

## SECTION 2

# SAFETY, TOOLS AND EQUIPMENT, SHOP PRACTICES

## UNIT 7: TUBING AND PIPING

## UNIT OBJECTIVES

After studying this unit you should be able to

- list the different types of tubing used in heating, air conditioning, and refrigeration applications.
- describe two common ways of cutting copper tubing.
- list procedures used for bending tubing.
- discuss procedures used for soldering and brazing tubing.
- describe two methods for making flared joints.
- state procedures for making swaged joints.
- describe procedures for preparing and threading steel pipe ends.
- list four types of plastic pipe and describe uses for each.
- describe alternative, mechanical methods for joining pipe sections.



## Purpose of Tubing and Piping

- Provides a path for refrigerant to take
- Provides a means to return oil to the compressor
- Provides a means to supply oil or gas to heating appliances
- Provides a path for water to take in hydronic heating systems
- Proper installations prevent refrigerant and other fluid loss

## Types and Sizes of Copper Tubing

- Soft or hard drawn tubing
- “K” pipe is heavy duty
- “L” pipe is standard weight
- “M” and “DWV” are lighter weight piping
- ACR Tubing measured by outside diameter
- Nominal tubing is measured by inside diameter

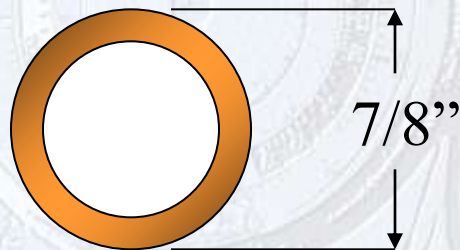


# Refrigeration & Air Conditioning Technology

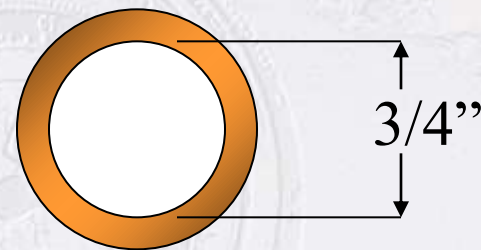
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## ACR and NOMINAL TUBING IDENTIFICATION

ACR TUBING



NOMINAL TUBING



Both pipes are physically the same size, but are identified differently depending on the application

## Tubing Insulation

- Insulating piping material prevents heat transfer between the fluid in the pipe and the surrounding air
- Reduces the formation of condensate on cold lines such as cold water lines or the suction line on an air conditioning system
- Increases the efficiency of hydronic heating systems by keeping the heat in the pipes
- Closed cell insulation is desired



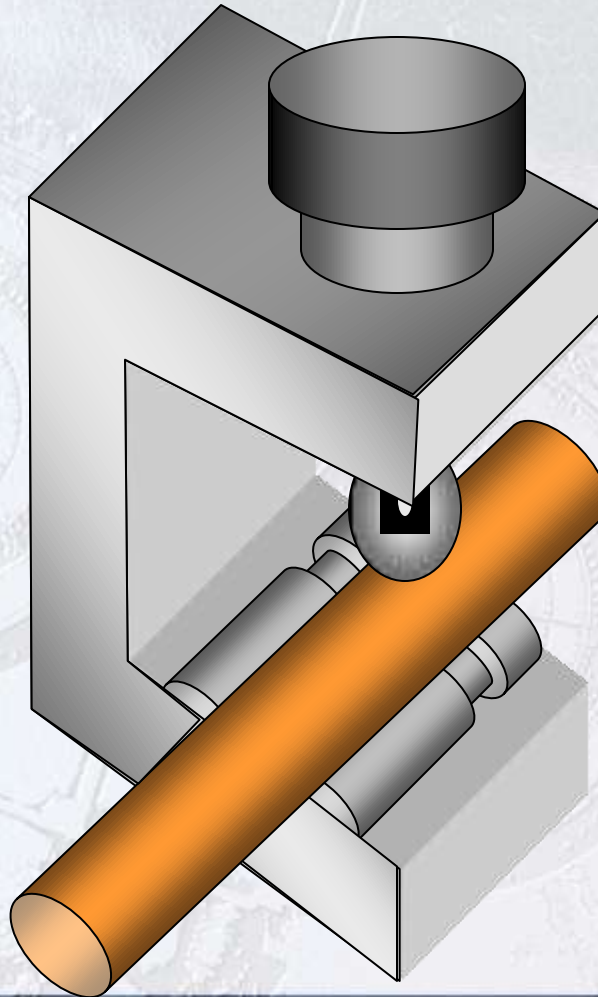
## Cutting Tubing

- Tubing can be cut with a hacksaw or tubing cutter
  - Tubing cutters for refrigeration lines and smaller tubing
  - Hacksaws for larger diameter piping material
- Remove burrs from tubing after cutting
- All cuts must be perfectly straight

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1. Mark the tubing at the desired cut point
2. Position the tubing on the rollers
3. Tighten the knob on the cutter until the cutting wheel comes in contact with the tubing
4. Rotate the cutter around the tubing



5. Tighten the wheel on the cutter
6. Continue rotating and tightening the knob until the tubing is cut
7. Maintain a moderate pressure on the wheel at all times and be sure to not over tighten the knob

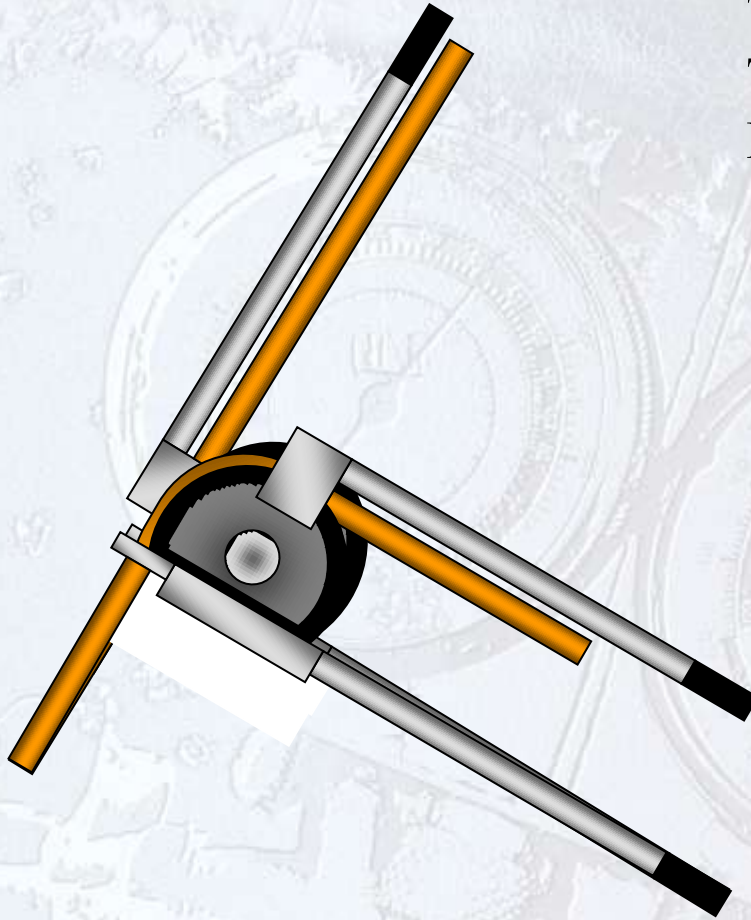


## Bending Tubing

- Only soft-drawn tubing should be bent
- Use as large a radius as possible
- Do not allow tubing to kink or flatten
- Tubing can be bent with a bending spring or lever-type bender
- Bending springs can be used on either the inside or outside of the tubing

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THE TUBING IS SECURED IN  
THE LEVER BENDER AT THE  
PROPER POSITION...

AS THE HANDLES ARE  
PULLED TOGETHER, THE  
BEND IN THE TUBING IS  
FORMED



## Soldering

- Process used to join piping material to fittings
- Soldering is done in the 500° F range
- Filler material is melted into the gap between the pipe and the fitting
- Filler material adheres to the fitting and pipe
- The filler material is called solder
- 50/50 solder is 50% tin and 50% lead
- 95/5 solder is 95% tin and 5% antimony

## Brazing

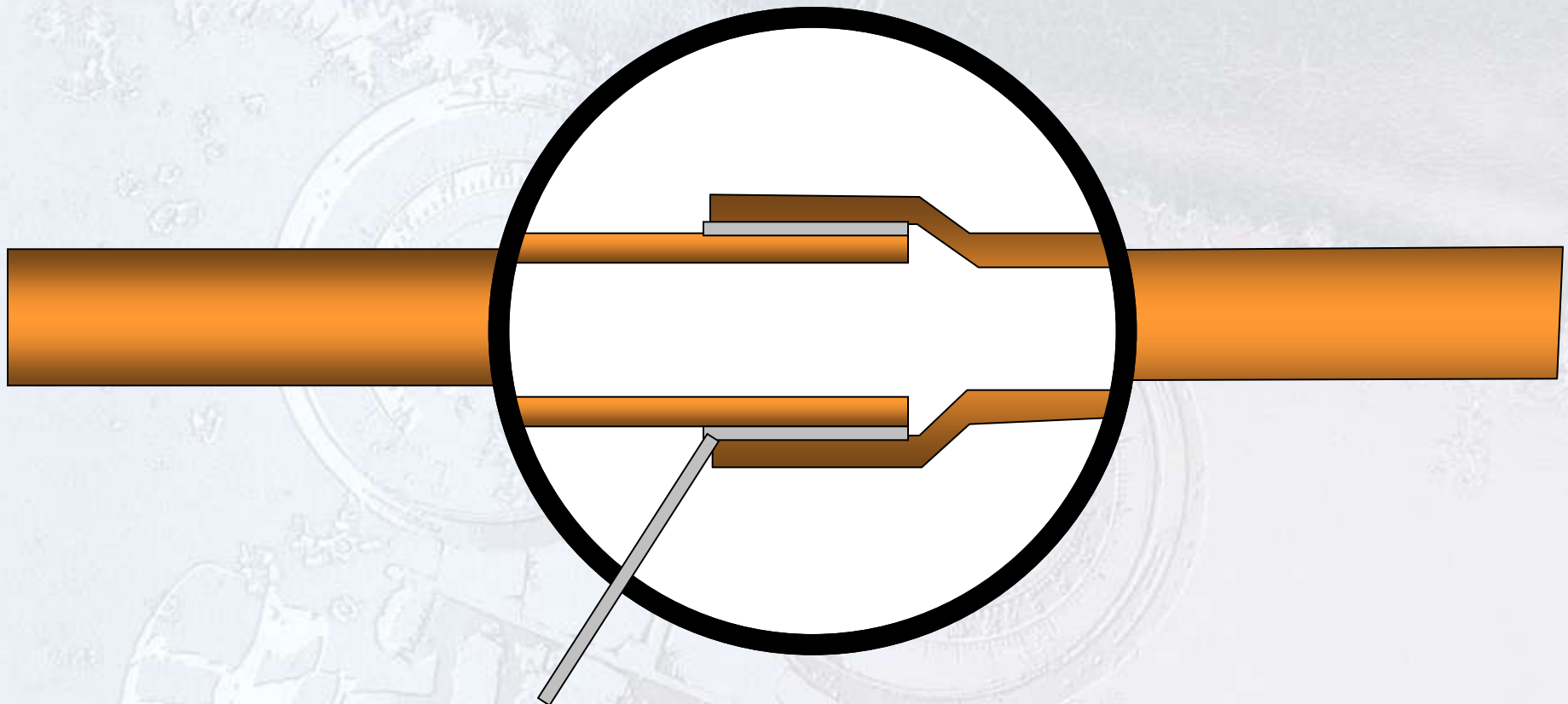
- Brazing is done in the 800° F range
- Filler material is melted into the gap between the pipe and the fitting
- The filler materials are called brazing rods, silver solder or hard solders
- Brazing alloys contain 15% - 60% silver or phosphorous copper



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PIPE IS INSERTED INTO THE FITTING



FILLER MATERIAL IS MELTED INTO THE GAP BETWEEN  
THE PIPE AND THE FITTING

## Heat Sources for Soldering and Brazing

- Torches – Propane, Butane, Air-acetylene and Oxy-acetylene torches are commonly used
- The torch kit consists of a fuel tank, regulator, hose and torch tips
- Torch tips are available in a wide range of sizes and styles



## Setting Up the Air-acetylene Torch

- Quickly open and close tank to free any dirt
- Connect regulator, hose and torch to tank
- Make certain torch handle valve is closed
- Open tank one-half turn
- Open torch handle valve and ignite fuel with a spark lighter and adjust flame
- Close all valves and bleed hose after use

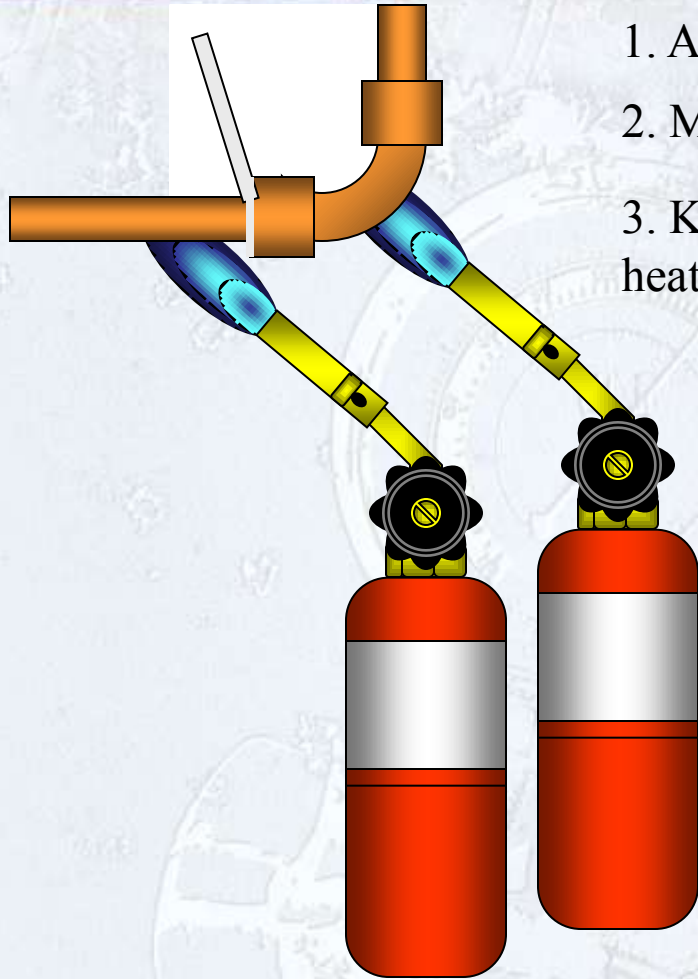
## Soldering Techniques

- Clean the end of the pipe as well as the inside of the fitting
- Apply flux immediately after cleaning
- Assemble the joint
- Heat and apply solder
- Wipe the joint after soldering to remove excess solder



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1. Apply heat to the tubing near the fitting
2. Move the torch and heat the fitting
3. Keep the torch moving from the tubing to the fitting to heat the entire joint
4. The inner cone of the flame should just touch the metal
5. Use the heat of the metal to melt the solder. Do not melt the solder with the torch
6. Feed solder to fill the joint
7. Do not use excessive amounts of solder
8. Wipe the joint clean

## Brazing Techniques

- Clean the pipes and fittings when necessary
- Introduce 1 to 2 psig of nitrogen to the piping circuit
- Light the torch and uniformly heat the joint
- The joint will be at the correct temperature when the joint glows cherry red
- Apply filler material to completely fill the joint



## Soldering and Brazing Tips

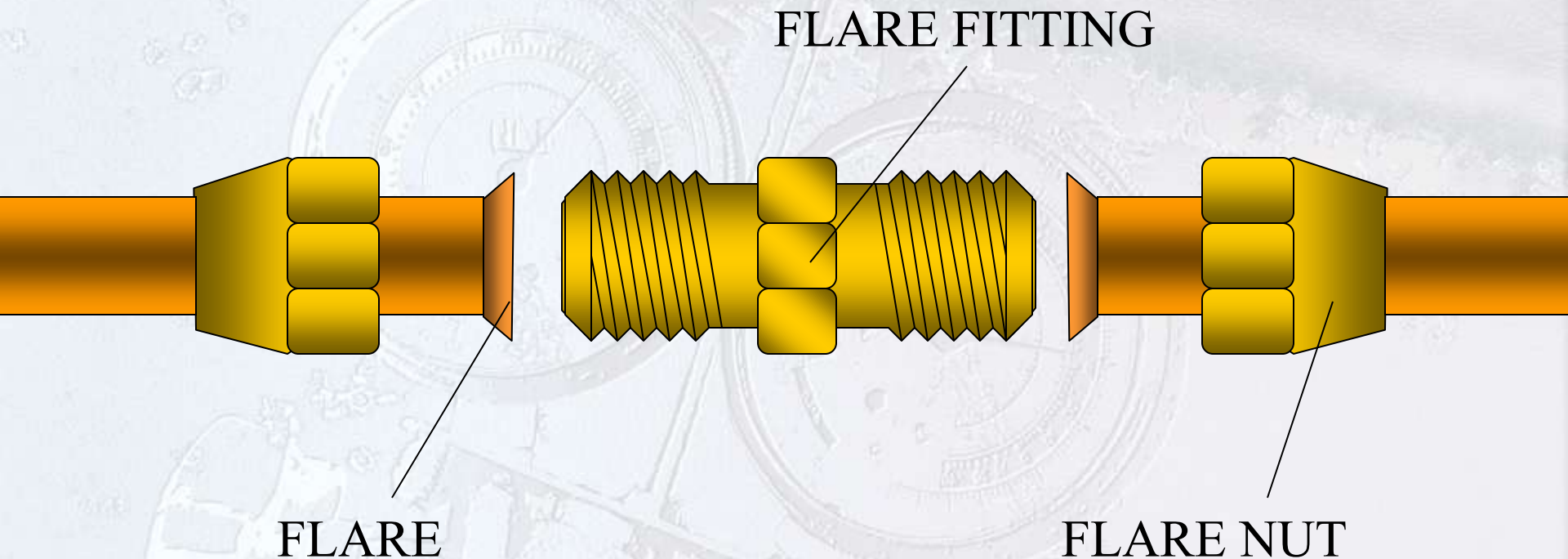
- Clean all surfaces
- Keep filings and flux from inside of pipe
- Filler material will flow toward the heat source
- Apply more heat to the fitting
- Do not overheat the joint
- Do not use too much filler material
- Clean all joint after soldering or brazing

## Making Flare Joints

- Cut tube to the desired length and ream
- Slip flare nut over the end of the tubing
- Clamp the tube in the flaring block
- Place the yoke over the flaring block
- Turn the yoke screw down firmly to flare
- Remove the yoke
- Inspect the flare



## ANATOMY OF A FLARE CONNECTION



## Swaging Techniques

- Involves expanding one end of a section of tubing to join two sections of same size tubing
- The joint is then soldered or brazed
- The depth of the swage should be equal to the diameter of the tubing
- A swaging tool and flaring block are needed to make a swage joint

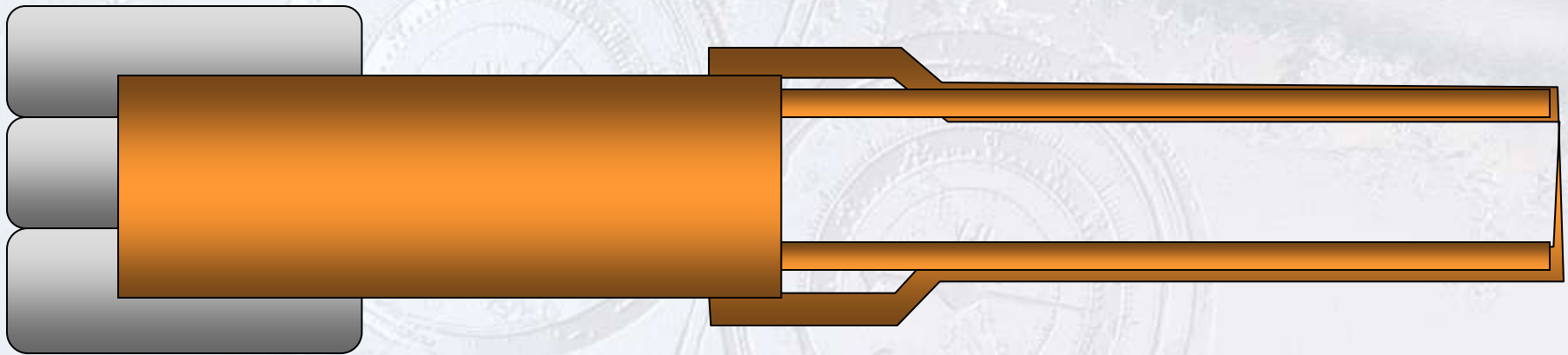


## Swaging Techniques

- Secure tubing in the flaring block
- The tube should extend from the block a distance equal to the diameter of the tube plus one-eighth of an inch
- Insert the swaging tool into the end of the tube
- Strike the swaging tool with a hammer until the proper shape and length has been obtained
- Inspect the swage

## Swaging Techniques

AS THE SWAGING TOOL IS STRUCK WITH A HAMMER,  
THE END OF THE TUBE EXPANDS



A SECTION OF SAME SIZE TUBING CAN THEN BE  
INSERTED INTO THE SWAGED SECTION



## Steel Pipe

- Seam welded or produced without a seam
- Black pipe or galvanized (zinc coated)
- Plumbing, hydronic and gas heating applications
- Pipe size is referred to as the nominal pipe size
- Nominal size is approximately equal to the inside diameter of the pipe

## Joining Steel Pipe

- Joined by welding or by using threaded fittings
- Tapered threads are used on pipe and fittings
- Tapered threads reduce the chance of leaks
- There should be 7 perfect threads and 2 imperfect threads for each joint



## Cutting Steel Pipe

- Pipe can be cut with a hacksaw or a pipe cutter
- All cuts must be perfectly square
- The pipe cutter is a larger version of the tubing cutter discussed earlier
- Over tightening the pipe cutter can result in the formation of a large burr in the pipe and the shortened life of the cutting wheel
- Ream the pipe after cutting is complete

## Threading Steel Pipe

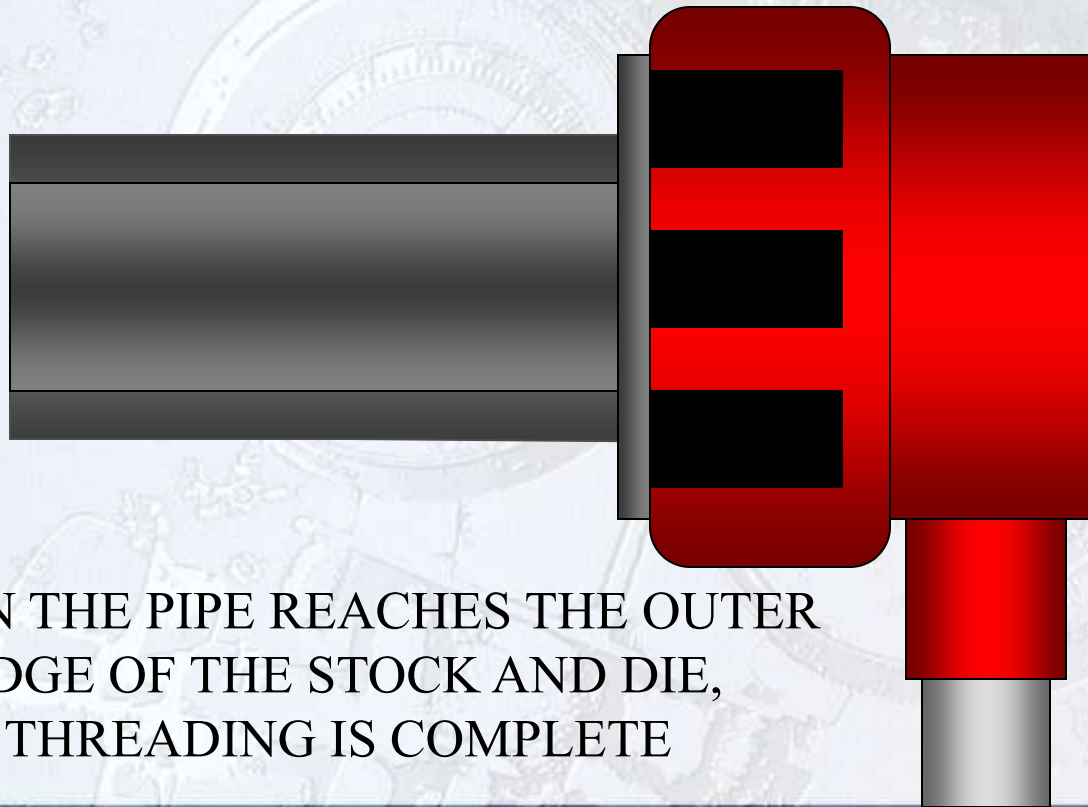
- Secure the pipe in a pipe vise
- Place cutting die on the end of the pipe and apply oil
- Turn the die onto the pipe, using the stock as a ratchet
- Turn the die one or two turns and then back the die off the pipe  $\frac{1}{4}$  turn
- Repeat oiling and threading until the pipe is flush with the far side of the die



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THE THREADING STOCK AND DIE ARE POSITIONED OVER THE PIPE AND TURNED TO CREATE THREADS



WHEN THE PIPE REACHES THE OUTER  
EDGE OF THE STOCK AND DIE,  
THREADING IS COMPLETE

## Installing Steel Pipe

- Pipe wrenches are used to hold and/or turn pipes and fittings
- Apply pipe dope to the male threads of the pipe
- Avoid getting dope on the two threads at the end of the pipe
- Use two wrenches to tighten a connection
- The wrenches should be positioned in opposite directions



## Plastic Piping Materials

- ABS – Used for water drains, waste and venting
- PE – Used for water, gas and irrigation systems
- PVC (polyvinyl chloride)
  - Can be used for high pressure applications
  - Can be used for low temperature applications
- CPVC (chlorinated polyvinyl chloride)
  - Used for temperatures up to 180° F
  - Used for pressures up to 100 psig

## Preparing PVC and CPVC for Joining

- Cut the pipe square
- Remove any burrs from the end of the pipe
- Clean the end of the pipe with primer
- Apply cement to the inside of the fitting and the outside of the end of the pipe
- Insert the pipe all the way into the fitting
- Turn pipe about  $\frac{1}{4}$  turn and hold for 1 minute



## Unit Summary

- Copper tubing can be soft or hard-drawn
- Copper tubing is identified as K, L, M, or DWV
- ACR tubing is measured by its outside diameter
- Nominal tubing measured by its inside diameter
- Piping operations include cutting, bending, flaring, soldering and brazing
- Steel pipe joined by welding or by using threaded fittings
- Plastic pipe can be ABS, PE, PVC, or CPVC