Hand and Power Tools Part 1: Overview, Basic Hand & Power Tools

Transmission Underground Training

Instructor Guide

2022

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HAND AND POWER TOOLS PART 1 - DIRECTIVES

Overview

This will provide you the information necessary to train employees on Hand and Power Tools Part 1 concepts and tasks.

About the Course

The following table identifies key components of this training.

Training Program/Plan	
Course Title:	Hand and Power Tools Part 1
Course Code:	TBD
Revision Date:	N/A
Revision Number:	0
Course Duration:	TBD
Prerequisites:	
Evaluation Methods:	Checkpoints and Knowledge Checks
References:	Handheld and Powered Hand Tools; Lessons Learned-Suggested Procedure Improvement to the FAM for Construction & Maintenance; Hi-Pot Adapter with Analog Voltmeter Phase Sticks

Required Materials

The following materials are required for this training.

Instructor	Student
• Instructor Guide • Student Guide • PowerPoint • Laptop w/internet/intranet • Overhead Projector • Job Brief • Safety Manual • Training Area • Props • Appropriate PPE	• Student Guide • Supplemental – OJT Book/JA • Appropriate PPE

HAND AND POWER TOOLS PART 1 – DIRECTIVES, CONT'D

Agenda The following is the suggested course agenda:

Time/ Duration	Activity
TBD	Introduction & Administration
	Course Overview, Objectives & Topics
	Hand and Power Tools Part 1
	Timesheets
	Checkpoint
	Evaluation

HAND AND POWER TOOLS PART 1 - DIRECTIVES

SG Page #1

Present PPT Slide #2, *Hand and Power Tools Part 1: Overview, Basic Hand and Power Tools, Amp Prob, Voltmeter*, refer to SG Pg. #1

Present PPT Slide #3, *Welcome*, refer to SG Pg. #1
Discuss all bullets emphasizing the emergency exits for building

Stop
Begin day with a Safety Message

Present PPT Slides #4-#6, *Hand and Power Tools Part 1 Module Overview/Objectives/Topics*, refer to SG Pg. #1

- Explain what the module entails, how long and what is going to happen
- Give examples of how this will benefit them (WIIFM)
- Explain the things they will be learning during each topic
- Set expectations

Use Three-Part Communication during class

- Don't fall into common human error traps, explain the importance
- Apply HP during topics, explaining each

Hand and Power Tools Part 1

Overview

In this module, you will learn about the various hand and power tools used to complete various jobs within Underground Construction. Upon review of the material, you will not only be able to correctly identify the power tools used but you will also be able to correctly use them at a jobsite while ensuring PEPCO's safety procedures are always being closely followed.

Objectives

Upon completion of this module, you will be able to:

- Discuss how to safely use general tools and equipment
- Recognize the various portable power hand tools used in UG Construction
- Explain the use for each hand tool used in UG Construction
- Describe how underground tools are used at the jobsite
- Demonstrate how to correctly use an Amp Probe
- Demonstrate how to correctly use a Voltmeter

Topics

The following topics will be covered during this course:

- General Tools and Equipment Safety
- Basic Hand Tools
- Portable Power Hand Tools
- Underground Tools
- Amp Probe
- Voltmeter

GENERAL TOOLS AND EQUIPMENT SAFETY – DIRECTIVES

SG Page #2

Present PPT Slide #7, *General Tools and Equipment Safety*, refer to SG Pg. #2

Present PPT Slide #8, *General Tools and Equipment Safety Overview*, refer to SG Pg. #2

Present PPT Slide #9, *Hand Tools – General Inspection*, refer to SG Pg. #2

General Tools and Equipment Safety

Overview

Safe and proper tool operation is a fundamental part of Underground work. Every task required can be performed safely and easily when the correct tools and equipment are safely used, and safe work practices are followed. This module identifies basic hand tools, power tools, and special use tools commonly used in Underground construction.

Hand Tools – General Inspection

Hand tools should always be clean and dry. They must never be rusted, dull, or worn. Parts that function improperly, and mechanisms that slip, are not safe to use.

Visually inspect hand tools for the following **general conditions**:

General Tools/Parts	Good Working Condition
Handles & Hand Grips	Tight and free from cracks or splinters
Wrench & Socket Wrench Jaws	Not stripped or sprung to point where they slip
Tools with Spreading Handles: • Bolt Cutters • Wire Cutter • Connector Presses	Some may have approved insulating handles
Tool Blades	Sharp

GENERAL TOOLS AND EQUIPMENT SAFETY, CONT'D - DIRECTIVES, CONT'D

SG Page #3

Present PPT Slides #10-#12, *Hand Tool – Specific Tool Inspection*, refer to SG Pg. #3

General Tools and Equipment Safety, Cont'd

Hand Tool – Specific Tool Inspection

Visually inspect all tools for company-approved handles. Check the specific tools shown in the table below for their proper working condition:

General Tools/Parts	Good Working Condition
Pliers	• Freely open & close ○ Clean/lubricate with approved oil if needed
Adjustable Wrenches	• Smooth jaw operations ○ Clean & lubricate worn gear as needed
Screwdrivers	• Tip is not worn or rounded ○ Replace any screwdrivers with worn tips
Hand Drills	• Chuck is not worn or loose

Hand Saws & Hacksaws	• Blades set correctly in handle (teeth set to cut in the proper stroke direction)
	  ○ Most saws cut in forward direction
	  ○ Some cut on the pulling stroke
	• Tight handle
	• Straight blade
	  ○ Dispose any bent blade

Knives	• Sharp, free of burrs/nicks
	  ○ Sharpen edge with speedy sharp or file if needed
	  ○ Use protective cover whenever possible

Hammers/ Claw Hammers	• Handle is not cracked; head is not loose • Claw is not broken or dented
Wire, Cable, & Bolt Cutters	• Freely opening/closing handle • No nicks or dents on edges • Jaws close together along the entire length of the blade

GENERAL TOOLS AND EQUIPMENT SAFETY, CONT'D - DIRECTIVES, CONT'D

SG Page #4

Present PPT Slide #13, *Hand Tools Precautions*, refer to SG Pg. #4

General Tools and Equipment Safety, Cont'd

Hand Tools Precautions

Hand Tools are used in almost every job performed by PEPCO employees, below are some basic precautions needed to safely use them.

- Only use tools for the purpose for which they were designed.
- **NEVER** throw tools.
- Place tools in a tool bag or attach them firmly to a handline if they need to be raised or lowered. Warn other employees to stand clear when raising or lowering tools.
- **DO NOT** use tools that are unsafe or defective.
- **DO NOT** leave tools laying around and do not let them get dirty or become a tripping hazard.
- Keep tool handles clean and free from oil and grease.
- **NEVER** rely on the hand tool handle cover to protect you from electrical shock.
- Use only company-approved tools.
- Treat tools as if they were your own.
- Inspect all tools and equipment before using them.

Go to the Management Model and access your utilities *Handheld and Powered Hand Tools* – CM-PH-802047

GENERAL TOOLS AND EQUIPMENT SAFETY, CONT'D - DIRECTIVES, CONT'D

SG Page #5

Present PPT Slides #14-#16, *Hand Tools Precautions, Cont'd*, refer to SG Pg. #5

General Tools and Equipment Safety, Cont'd

Hand Tools Precautions, Cont'd

Use only company approved tools and equipment and use them according to the manufacturer operating and safety instructions. Hand Tools must always be clean, dry, and never rusted, dull or worn. Parts of the tools that work improperly and mechanisms that slip are not safe to use.

Follow these best practices to protect yourself when using Hand Tools:

Step	Action
1	Always wear Personal Protective Equipment (PPE) when operating or using tools and equipment.
2	Do **NOT** use Hand Tools with the following conditions: • Screwdrivers with metal shanks extending through the handle. • Metallic rulers or rulers with metallic bindings or tape lines in energized areas.
3	**NEVER** strike the hardened part of one tool against the hardened part of another tool, for e.g., two hammer heads.
4	Check the immediate area for safe clearances from equipment and other persons before swinging tools, such as a hammer.
5	**ALWAYS** make sure a tool is clean and dry with no rust or chemical spills.
6	**ALWAYS** check that handles and hand grips are tight and free from cracks or splinters.
7	**INSPECT** abrasive wheels for cracks and chips and take a ring test for replacement wheels.
8	**ALWAYS** confirm that wrench and socket wrench jaws are not stripped or sprung to the point where they slip.
9	Check that all tools with blades are sharp.
10	Check tools with spreading handles, such as bolt cutters, wire cutters, and connector presses, have approved insulating handles.
11	Store or put away tools when not in use: • Use approved tool holder to store company approved tools. • Cover sharp edge of blade tools. • Place tool in proper scabbard or cover.

BASIC HAND TOOLS – DIRECTIVES

SG Page #6

Present PPT Slide #17, *Basic Hand Tools*, refer to SG Pg. #6

Present PPT Slide #18, *Basic Hand Tools Overview*, refer to SG Pg. #6

Basic Hand Tools

Basic Hand Tools Overview

A professional craftsman respects his tools, carefully maintains them so that they will last for a long time and recognizes the dangers of misusing tools. Worn or broken tools can be dangerous to you and those around you. Worn tools should be repaired or replaced -- the cost of a new tool is small when compared to the cost of an injury.

Tool Bag Type	Use	Visual Reference
Material/Nose Bag	Holds tools or small equipment inside the manhole.	
Double Handle Bag (URD BAG)	Holds URD tools, materials, and equipment	
Trouble Box	To store tools and use when performing work during trouble.	
Possible Hazards: Line of Fire		

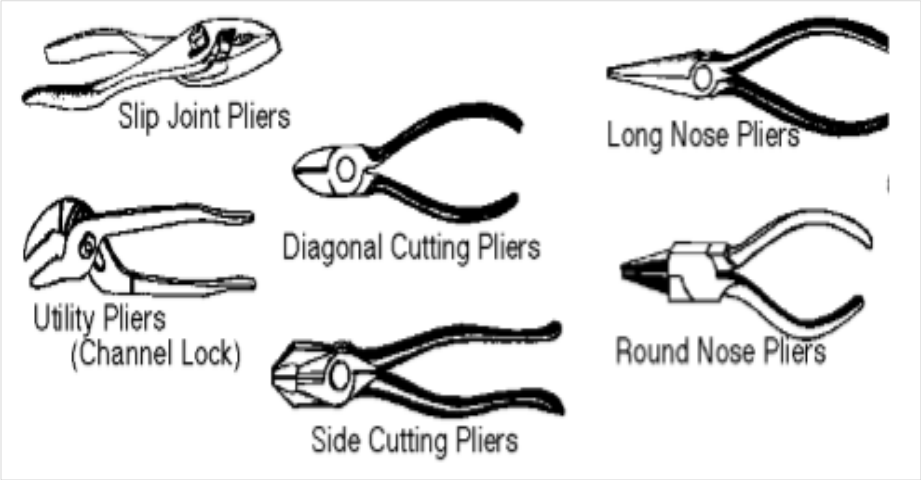
BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #7

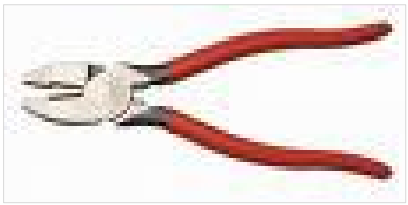
Present PPT Slides #19-20, *Pliers*, refer to SG Pg. #7

Basic Hand Tools, Cont'd

Pliers



There are three basic types of pliers:

Use	Image
• **Lineman's/Side cutting pliers** are used to cut or twist small gauge copper or aluminum wires. ○ **DO NOT** use lineman pliers for holding objects in a flame ○ The pliers' sides can be used to lightly tap an object when stuck, but do not pound with the pliers ○ Diagonal cutting pliers for removing cotter pins and cutting small control wires	 

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #8

Present PPT Slide #20, *Pliers, Cont'd*, refer to SG Pg. #8

Present PPT Slide #21, *Pliers: Rules of Thumb*, refer to SG Pg. #8

Basic Hand Tools, Cont'd

Pliers, Cont'd

Use	Image
• **Long-Nose/Needle Pliers** are useful for splicing and terminating cable and for performing other tasks. They form circular eyes in control wires for connecting to switch boards and instrument terminals. They can be used to reach into awkward places and do work that would be difficult to perform with other tools. **DO NOT** use this type of plier to loosen or tighten a nut or bolt. • **Utility Pliers/Eagle Beaks** (channel locks) are used to tighten, open and squeeze macks.	 

Pliers: Rules of Thumb

Rules of thumb are simple basic safety rules to be followed while using pliers.

#	Safety Rules While Using Pliers
1	**DO NOT** use pliers as a substitute for a hammer, wrench, pry tool, or other tool. You may damage the tool and/or hurt yourself.
2	**DO NOT** push pliers beyond their capacity. Do not extend the length of the plier's handles. Do not use needle-nose pliers to bend stiff wire. Cut heavy wire or bolts with an appropriate cable cutter or bolt cutter.
3	**NEVER** depend on plastic-dipped handles to insulate you from electricity. These handles are used for comfort and a firmer grip, but do not protect against electric shock.

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #9

Present PPT Slide #21, *Pliers: Rules of Thumb*, refer to SG Pg. #9

Present PPT Slide #22, *Wrenches*, refer to SG Pg. #9

Basic Hand Tools, Cont'd

Pliers: Rules of Thumb, Cont'd

Step	Action
4	Pliers can be used to tap objects, but never used as a hammer.
5	Pliers will require light lubrication.
6	Plier handles should be covered to provide a good grip.

Possible Hazards: Getting fingers caught in the mouth of pliers.

Wrenches

Whatever the job, only a wrench of the proper type and size will give you the kind of results you want with less effort and more safely than any other wrench. Follow the safety rules/guidelines below when working with rubber gloves, leather protectors, and rubber sleeves.

Always keep the open face away from you and pull toward the body when tightening or loosening. When using adjustable wrenches, the force of the pull should be exerted against the fixed jaw not the adjustable jaw. Also, do not place a pipe on the end of the wrench handle to gain better leverage. This will overstress the mechanism.

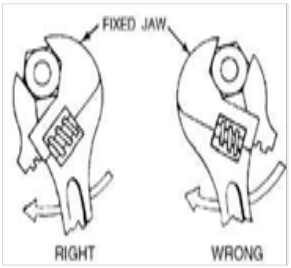
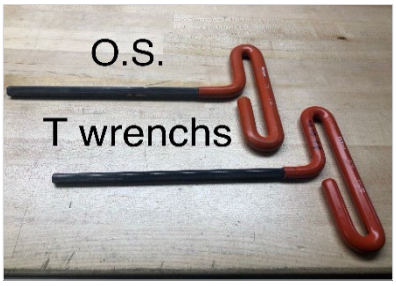
BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #10

Present PPT Slide #23, *Wrenches, Cont'd*, refer to SG Pg. #10

Basic Hand Tools, Cont'd

Wrenches, Cont'd

Use	Image
• **Adjustable wrenches (Crescent)** are designed to fit wide range of bolt heads/nuts. ○ Jaws of the wrench should be tightly adjusted around the nut. ○ Pulling force should be against the fixed jaw. ○ Not to be used as a hammer.	
• **Socket Wrench** -The ratchet wrench has one handle with interchangeable sockets to accommodate various fasteners. The socket is designed to fit around all the faces of a specific size bolt or nut and grip each corner. ○ The handle is equipped with the ratchet. ○ The star socket is used to remove lags.	
• **Closed End Ratchet Wrench** can take the place of the socket wrench in some situations.	
• **T-wrenches** are used on fasteners that have hexagon slots on the head. They are made from hexagonal T-shaped bars of steel. ○ Use correct size to prevent rounding or spreading the head of the screw.	

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #11

Present PPT Slide #24, *Wrenches, Cont'd*, refer to SG Pg. #11

Basic Hand Tools, Cont'd

Wrenches, Cont'd

The proper way to use the wrench is to push or pull it in the direction of the jaw opening.

Use	Image
• **A Hex key, Allen key, or Allen Wrench** is a tool that is used to drive bolts and screws with hexagonal sockets in their heads.	
• **Box Wrench** is used for standard size fasteners. • **678/66s** is used on specific standard size fasteners.	
• **Open End Wrench** is a wrench with jaws having a fixed width of opening at one or both ends of the handle. ○ This tool is used for loosening and tightening fasteners such as nuts and bolts. They come either separately or in a combination form, with one end being an open wrench, while the other is boxed.	

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #12

Present PPT Slide #25, *Wrenches: Rules of Thumb*, refer to SG Pg. #12

Basic Hand Tools, Cont'd

Wrenches: Rules of Thumb

Rules of thumb are simple basic safety rules to be followed while using wrenches.

Step	Action
1	**DO NOT** use a wrench as a substitute for a hammer, pry tool, or other tool. You may damage the tool and/or hurt yourself.
2	Be sure that the wrench opening fits the fastener to avoid damage to the tool and/or the fastener.
3	**DO NOT** push a wrench beyond its capacity. Wrenches are sized to keep leverage and intended load (torque) in balance.
4	**DO NOT** use an artificial extension on the handle of a wrench. You may break the wrench, spoil the work, and hurt yourself.
5	**NEVER** push on a wrench unless necessary. Pull on a wrench to exert even pressure and avoid injury if the wrench slips or the nut breaks loose. If you must push the wrench, use the palm of your hand and keep your palm open.
6	**DO NOT** cock or tilt an open-end wrench. Be sure the nut or bolt head is fully seated in the jaw opening.
7	Use a box or socket wrench on hard-to-reach fasteners.
8	Be sure that adjustable wrenches grip tightly. Pull so that force is applied to the fixed jaw.
9	**DO NOT** use an artificial extension on the handle of a wrench. You may break the wrench, spoil the work, and hurt yourself.
10	**NEVER** depend on plastic-dipped handles to insulate you from electricity. These handles are used for comfort and a firmer grip, but do not protect against electric shock.
11	Attempts to repair wrenches are not recommended.

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #13

Present PPT Slide #26, *Cutters,* refer to SG Pg. #13

Basic Hand Tools, Cont'd

Cutters

Each cutter is designed to do a certain job. Using the right tools makes for an efficient and safe job.

Use	Image
• **Chain Cutter** is used for cutting larger gauge copper and aluminum wire and cable.	
• **Large Cable Cutters** are used for cutting medium gauge copper and aluminum wire and cable.	
• **Small Cable Cutters** (Pruners) are used for cutting small gauge copper or aluminum wire. When using a small cable cutter: ○ Hold the handle ends for the greatest leverage. ○ Tape bare stranded conductors at the point to be cut and cut through the tape. This prevents the strands from unraveling. ○ **DO NOT** move the position of the blades when easing up on the handle for another cut. This prevents the cutters from chewing through the cable.	

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #14

Present PPT Slide #27, *Cutters, Cont'd*, refer to SG Pg. #14

Basic Hand Tools, Cont'd

Cutters, Cont'd

Use	Image
• **Bolt Cutters** are used to cut hardened objects, bolts, and wire. The longer the handles the greater the mechanical advantage. Before cutting wire, tape the wire at the location where the cut is to be made. • The size of the cutter should match the size of the wire being cut. • This type of cutter may flatten soft wire like copper and aluminum.	
Cable Cutters are similar in appearance to bolt cutters but have curved jaws. Cutters cut by applying pressure around the wire, so the wire is cut evenly. **DO NOT** use cable cutters on steel wire because the steel can chip the jaws. Cable cutters are available in different lengths and styles. • **Chain Retched Cable Cutters** are used to cut coper/aluminum electrical cables and are normally sized between 1000 -1500 cables. • **Hand Ratchet** is a small and light weight cutter that is used for work in confined spaces. These 24 and 36-inch cutters are used for ordinary work. • **High Leverage Ratchet** has a ratcheting action to prevent the need for great strength to cut large wire.	

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #15

Present PPT Slide #28, *Cutters: Rule of Thumb*, refer to SG Pg. #15

Present PPT Slide #29, *Saws*, refer to SG Pg. #15

Present PPT Slide #30, *Hammers*, refer to SG Pg. #15

Basic Hand Tools, Cont'd

Cutters: Rule of Thumb

Cutters are NOT intended for use on steel and plastic handles are not intended for protection against electrical shock.

Saws

Identifying the type of material to be cut is important in selection of a saw. Always take care when using a saw because of small cutting debris.

Use	Image
Hack Saw is primarily used for cutting small metallic items. • Cut on forward stroke. A proper stroke will maintain at least two teeth on the material that is being cut. • Install blades with teeth pointing forward.	

Hammers

Hammers have a variety of uses. Choosing the right hammer makes for a safe job.

Use	Image
Tinners Riveting Hammers are lightweight and used in UG for splicing (lead joint work) and hacking lead. • Handle made of either wood or fiberglass. • Used entire handle for most effective use.	

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #16

Present PPT Slide #31, *Hammers, Cont'd* refer to SG Pg. #16

Present PPT Slide #32, *Hammers: Rules of Thumb*, refer to SG Pg. #16

Present PPT Slide #33, Screw Drivers, refer to SG Pg. #16

Basic Hand Tools, Cont'd

Hammers, Cont'd

Use	Image
Double Faced Hammer is heavier weight and used to drive bolts or help with arm installation/removal. • **NEVER** strike hammer face against hardened tool (e.g., another hammer).	
Sledgehammer is used for striking manhole covers and gratings to loosen for ease of access. • Always strike object squarely.	

Hammers: Rules of Thumb

Rules of thumb are simple basic safety rules to be followed while using hammers.

- **NEVER** use one hammer to hit another
- **NEVER** use a damaged or worn hammer
- Discard any damaged tool
- Strike square blows, avoid glancing hits
- **NEVER** strike the side (cheek) of hammer
- Always check that the handle is **NOT** cracked, and the head is **NOT** loose

Screw Drivers

The size of the screw and the type of opening of the screw determines which driver to use. There are a few tips on how to use a driver that can be of benefit because screwdrivers are the most often misused and abused hand tool of all. Mentioned below are some commonly used screwdrivers:

- **Straight Slot -** is used on straight slot screw head
- **Phillips Head -** is used on Philips's head screws

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #17

Present PPT Slide #34, *Screwdriver: Rules of Thumb*, refer to SG Pg. #17

Present PPT Slide #35, *Knives*, refer to SG Pg. #17

Basic Hand Tools, Cont'd

Screw Drivers Rules of Thumb

Rules of thumb are simple basic safety rules to be followed while using screwdrivers.

- Check that the tip is not worn or rounded. Remove screwdrivers with worn tips.
- Select the proper size screwdriver to prevent stripping the head of the screw.
- Pre-drill holes for screws when wood is extremely hard.
- Do not use any other tool for leverage when tightening or loosening with a screwdriver.
- Do not use a screwdriver to pry, open, or punch objects.

Knives

A knife is used for a variety of tasks. When used with care, a knife can be a safe, reliable tool. Dull cutting-edge tools are dangerous, as they require excessive pressure to make them cut. Keep tools sharp and always cut away from the body. Mentioned below are some commonly used Hook Knives:

Use	Image
Splicing Knife, the most crucial tool of a cable splicer is a sharp knife. When splicing you use knives at all stages of the job. • Used to prep cables • Used to cut insulation and can pencil paper or rubber cables • Used to remove semi-conducting and shielding tapes • Aid in removal of jacketing materials and joint construction	
Hack Knives are used in a variety of ways: • They are used to remove lead sheaths from PILC and RILC • Ringing and cutting lead, and to open sleeves that are being broke down • Great care must be exercised when using a lead knife so that cable components are not damaged	

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #18

Present PPT Slide #36, *Knives: Rules of Thumb*, refer to SG Pg. #18

Basic Hand Tools, Cont'd

Knives: Rules of Thumb

Listed below are simple basic safety rules to be followed while using knives.

- **DO NOT** substitute a knife for another tool; it is not a screwdriver or a chisel.
- **DO NOT** expose a knife to excessive heat. Heat may ruin the tool.
- **DO NOT** depend on the plastic handle to insulate you from electricity. The handle is made for comfort and a firmer grip, but not as protection against electric shock.
- **DO NOT** pull a knife toward you. When removing insulation, carving, etc., always cut away from yourself.
- Keep your knife clean and sharp. Follow these rules when sharpening:
  - Rigidly support the knife being sharpened
  - File or stone away from the cutting edge
- Restore the original contour of the cutting edge.
- Check that the blade is clean and sharp. Use a whetstone or file with handle to sharpen the blade as needed.
- An approved knife will have a finger guard to protect against cuts to the glove or the fingers and hand. **ALWAYS** cut away from your body to avoid cutting yourself. **Do not put yourself in the Line of Fire!**

Note: It is acceptable to cut off to the side.

- **ALWAYS** keep knives sheathed while not in use.

Note: Wear *Kevlar* gloves if using an unprotected sharp bladed tool, open bladed knife, or saw. If wearing rubber gloves with leather protectors, it is strongly recommended to wear Kevlar gloves under the rubber glove.

BASIC HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #19

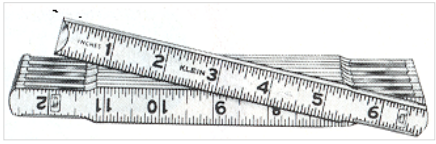
Present PPT Slide #37, *Measuring Devices*, refer to SG Pg. #19

Present PPT Slide #38, *Measuring Devices: Rule of Thumb*, refer to SG Pg. #19

Basic Hand Tools, Cont'd

Measuring Devices

Tapes and rules play a critical role in our work. Whether it is measuring dimensions of a splice or the amount of cable to be installed in a manhole they are an integral tool to a skilled worker. Mentioned below are some commonly used measuring devices:

Use	Image
• **6ft Folding** is used for a variety of measuring	
• **100ft Tape Measure** is used for much greater distances than a folding rule	

Measuring Devices: Rule of Thumb

Rules of thumb are simple basic safety rules to be followed while using measuring devices.

Keep the instrument clean and discard worn or damaged tool.

CHECKPOINT #1 – BASIC HAND TOOLS – DIRECTIVES, CONT'D

SG Page #20

Present PPT Slide #39, *Checkpoint #1 – Basic Hand Tools*, refer to SG Pg. #20

Present PPT Slides #40-#41, *Checkpoint #1 – Basic Hand Tools*, refer to SG Pg. #20

Answer Key:

1. D. - Clean and dry, never rusted, dull, or worn – Pg. #2 - Hand Tools – General Inspection
2. False. - Pg. #4 - Hand Tool Precautions
3. C. Side Cutting Pliers, Long Nose Pliers, and Utility Pliers – Pgs. 7 & 8 -Pliers
4. D. - All the above – Pg. #9 - Wrenches
5. C .- Crescent – Pg. $10 – Wrenches Cont'd.
6. B. - Socket Wrench – Pg. 10 – Wrenches, Cont'd

Checkpoint #1 – Basic Hand Tools

Directions Answer each question provided below.

Duration This checkpoint should take ***10 minutes*** to complete.

Questions

1. What condition should hand tools be in when inspecting?
   a. Brand new
   b. A few cracks and splinters
   c. A little dull and worn, but functional
   d. Clean and dry, never rusted, dull, or worn

2. ***True or False***: A hand tool handle cover is enough to protect you from electrical shock.

3. What are the three basic types of pliers used in Underground?
   a. Slip Joint Pliers, Side Cutting Plier, and Diagonal Cutting Pliers
   b. Round Nose Pliers, Long Nose Pliers, and Utility Pliers
   c. Side Cutting Pliers, Long Nose Pliers, and Utility Pliers
   d. Side Cutting Pliers, Utility Pliers, and Round Nose Pliers

4. When using a wrench, always:
   a. Keep the open face away from you
   b. The force of the pull should be exerted against the fixed jaw
   c. Do not place a pipe on the end of the wrench handle to gain better leverage
   d. All the above

5. Another name for the Adjustable Wrench is:
   a. Half moon
   b. Curve
   c. Crescent
   d. Bowed

6. Which wrench has one handle with interchangeable sockets?
   a. Closed End Ratchet Wrench
   b. Socket Wrench
   c. Allen Wrench
   d. Open End Wrench

CHECKPOINT #1 – BASIC HAND TOOLS, CONT'D - DIRECTIVES, CONT'D

SG Page #21

Present PPT Slides #41-42, *Checkpoint #1 – Basic Hand Tools, Cont'd*, refer to SG Pg. #21

Answer Key:

7. True. - Pg. #13 - Cutters
8. True. - Pg. #15 – Saws
9. True. - Pg. #15 – Hammers
10. True. - Pg. #17 - Knives

Checkpoint #1 - Basic Hand Tools, Cont'd

Questions, Cont'd

7. ***True or False:*** Another name for the Small Cable Cuter is called "Pruners".

8. ***True or False***: The Hack Saw is used for cutting small metallic items.

9. ***True or False***: Tinners Riveting Hammers are lightweight and used in UG for splicing (lead joint work) and hacking lead.

10. ***True or False***: Hack Knives are used to remove lead sheaths from PILC and RILC.

PORTABLE POWER HAND TOOLS – DIRECTIVES

SG Page #22

Present PPT Slide #43, *Portable Power Hand Tools*, refer to SG Pg. #22

Present PPT Slides #44-#45, *Power Tools Overview*, refer to SG Pg. #22

Portable Power Hand Tools

Power Tools Overview

A Power Tool is operated by an additional power source and can be portable, which increases its mobility.

- *Examples* of Portable Power Tools include:
    - Drills
    - Hammer Drills
    - Band Saw
    - Sawzall
    - Electric Blower
    - Cutters
    - Press

When it is not practical or possible to use hand tools for a given job, there are several available power tools and sources. Electrical connections can be made to secondary conductors, generators can be used, and various battery powered devices are also available. The hydraulics from trucks and mobile equipment can also be used to power some tools.

It is frequently impossible to connect electric power tools to secondaries. In such cases portable generators are used to supply electric power to pumps, blowers, hammers, drills, saws, and temporary lighting. The engines for these types of generators can use either L.P. gas or gasoline as fuel.

Power tools are categorized according to the source of power: electric, pneumatic, powder actuated, hydraulic or gasoline. There are several types of portable, power driven tools in common use in Underground Construction including:

- Hammers - for breaking driving, drilling, and chipping.
- Drills - for boring or drilling holes.
- Saws - for cutting trees, cable, and metal.

In the following sections we will be discussing various points of instruction and operation as a guide to perform safe and efficient operation of the various portable power tools and equipment.

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #23

***Present PPT Slide #46**, Power Tool Preparation* refer to SG Pg. #23

Present PPT Slide #47, *Power Cord Safety and Testing Steps*, refer to SG Pg. #23

Portable Power Hand Tools, Cont'd

Power Tool Preparation

Electric power tools with improperly working parts can cause severe injury to the user. Inspect all electric power tools for the following:

- Check that power cords, extension cords and plugs are not cut or damaged.
- Inspect grounded tools for periodic ground check tags.
- Check that all extension cords are rated for the electric tool load.
- Check that tools are clean and dry with no rust or chemical spills. Refer to the manufacturer's instructions to oil or lubricate the tool as necessary.
- All electric power tools used in line work areas must have one of the following: Double insulation with a proper label identifying the tools as double insulated (OSHA).
- A ground wire with the ability to connect it (OSHA).
- An insulating transformer to power electric tools that have no ground or double insulation (OSHA).
- Check that tool guards are in place and function properly and all tool blades are sharp (OSHA).
- Check that grinding equipment is protected with guards (OSHA).
- Refer to the manufacturer's instruction manual and test all power and setting switches for proper function before starting work activity (OSHA).
- **DO NOT** operate a machine unless professionally trained and authorized by the Person in Charge (PIC).
- Inspect batteries in all battery-operated tools.

Power Cord Safety & Testing Steps

When using electric tools with power cords, follow the steps below:

Step	Power Cord Safety & Testing Steps
1	Straighten out the power cord to provide maximum reach with the tool.
2	Keep the power cord trailing behind the tool and away from the cutting mechanism.
3	Turn off the tool and check the power cord to see if it is plugged in or check the fuse when the tool suddenly stops.
4	When safety permits, the power cords can be taped to the extension cord to prevent the cord from disconnecting.

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #24

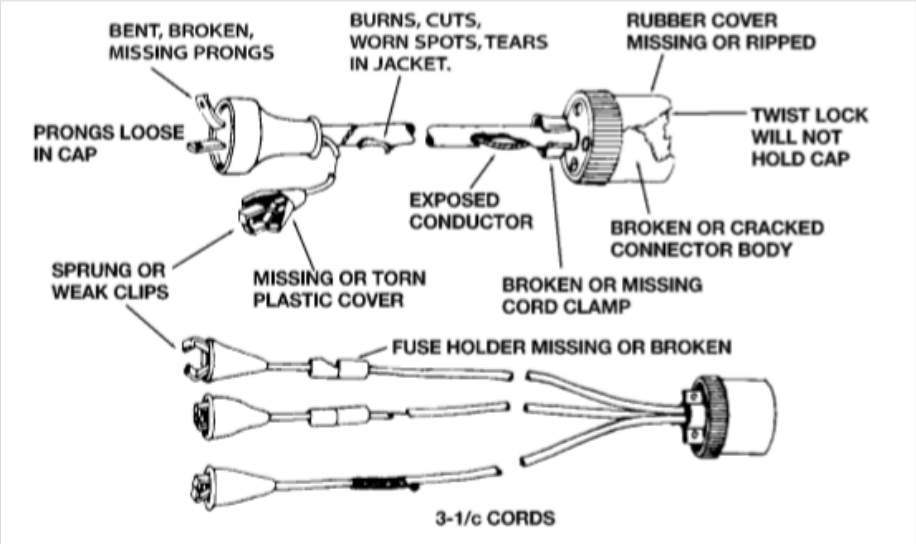
Present PPT Slides #48-#49, *Power Cords Safety and Testing Steps*, refer to SG Pg. #24

Portable Power Hand Tools, Cont'd

Extension & Power Cords Safety & Testing

Examine all extension and power cords while they are de-energized, and follow the steps below:

Step	Extension & Power Cords Safety & Testing Steps
1	Look for bent, broken loose or missing prongs.
2	Check for sprung or weak clips.
3	Look for missing or torn plastic covers and broken fuse holders.
4	Examine the cord length for burns, cuts, worn spots and tears.
5	Check the length of the cord for exposed conductors and confirm that the rubber cover is not missing or ripped.
6	Check that the twist lock will hold the cap.



Wires are color coded to indicate the specific type of conductor used in power and extension cords. Color identification is:

- Green – grounding conductor
- Black – 120/240-volt conductor
- White – neutral conductor

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #25

Present PPT Slide #50, *Hydraulic Tool Inspection*, refer to SG Pg. #25

Present PPT Slide #51, *Hydraulic Tool Handling and Safety*, refer to SG Pg. #25

Portable Power Hand Tools, Cont'd

Hydraulic Tool Inspection

#	Hydraulic Tool Inspection
1	Check the hydraulic fluid levels and add only approved fire-resistant fluids as needed.
2	**DO NOT** use brake fluid in hydraulic tools.
3	**DO NOT** allow dirt to enter the hydraulic system.
4	Check the spring tension buttons on die seats before connecting the tool to the pressure source.
5	Place a die in the tool and depress the button.
6	Lock the die in the tool and release the button.
7	Check that the die securely seats in the tool.
8	Check the fluid level in hydraulic reservoirs and add only approved fire-resistant fluids as required (OSHA).
9	Check the crankcase engine and circulating oil levels before operating unit. Add the correct type of oil as needed for each location.
10	Check that all washers and couplings are in place and in good condition.
11	**DO NOT** use the hose to raise or lower the tool (OSHA).
12	Shut off the compressor or hydraulic pump that pressurizes the hydraulic reservoir and bleed off the system pressure before disconnecting the tools unless the tool has a quick coupling device.

Caution: All hydraulic tool/hose inspections should be done before any connections are made to ensure the system being inspected does not contain any pressure.

Hydraulic Tool Handling & Safety

Handling Hydraulic Hose

- Straighten out the hoses and eliminate the kinks before charging or pressurizing the hoses.
- Protect the hoses from traffic.
- Place boards on both sides of the hose to keep the weight off the hose.
- **DO NOT** bend the hose in a circle with a radius less than 9 inches or drag the hose along rough surfaces, objects or building corners.

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #26

Present PPT Slide #52, *Hydraulic Tool Handling and Safety, Cont'd*, refer to SG Pg. #26

Present PPT Slide #53, *Tools with Adjustable Controls*, refer to SG Pg. #26

Present PPT Slide #54, *Power Driven Hammers*, refer to SG Pg. #26

Portable Power Hand Tools, Cont'd

Hydraulic Tool Handling & Safety, Cont'd

- Instrumentation
  - Use a dipstick or other measuring gauge to make visual checks of the fluid levels as necessary.
  - Periodically check instruments to verify safe operating conditions while operating compressor or hydraulic pump.
- Lay tools flat when not in use.
- Allow the tool to do the work. **DO NOT** use excessive pressure or force when working with the tool.
- **NEVER** try to stop a machine with your hands. Do not use any part of body as a brake.

Hydraulic Presses

- Store the presses and dies in the cases provided by the manufacturer to avoid nicking or scoring dies.
- Wipe off any inhibitor compounds from the tools.
- **DO NOT** store or use press with the hose end of pump in an elevated position.

Tools with Adjustable Controls

Do not lock the trigger switch on tools equipped with one. Set the speed control before starting when the tool is so equipped. Adjust depth or cutting angles before operating.

Power Driven Hammers

Use	Image
Hammer Drills are used to break concrete and have multiple uses, for example, they come with different type of adapters. For the Underground, the primary function is to drill holes into the concrete to install anchors.	

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #27

Present PPT Slide #55, *Power Drills*, refer to SG Pg. #27

Portable Power Hand Tools, Cont'd

Power Drills

Use	Image
Electric drills come in a 3/8 inch and 1/2-inch size based on the maximum size opening of the drill chuck. Some larger drills have detachable handles so they can be operated with two hands while other smaller drills are more like common household power drills. • These drills can be battery powered, plugged into generators, or clipped onto secondaries to receive power. • Common applications for such drills include pole framing as well as metal and masonry drilling. • When boring holes, the bit should be tightly engaged in the chuck and kept as perpendicular to the pole as possible. • If a wood bit tends to pull itself into the wood too quickly, it will slow the drill down. Pull back to allow the drill bit to empty shavings.	
• If drilling while aloft, take care not to drill through the safety strap. • When drilling metal, first drill a center punch to mark the hole location and start the cutting action.	

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #28

Present PPT Slide #56, *Power Drills, Cont'd*, refer to SG Pg. #28

Present PPT Slide #57, *Power Drills: Rules of Thumb*, refer to SG Pg. #28

Portable Power Hand Tools, Cont'd

Power Drills, Cont'd

Use	Image
Portable Battery Drill is used for loosening and tightening bolts and sheer bolts. • Operated portable drill needs to be recharged every night. • Observe proper safe body and equipment clearance when using in primary area. • It **MUST** have secondary handle.	

Power Drills: Rules of Thumb

Rules of thumb are simple basic safety rules to be followed while using drills.

- Always use only sharp, true bits, Dull or chipped bits can injure you.
- Always use the correct size bit for job and tighten it properly with chuck key.
- Keep the drill perpendicular to the drill hole to avoid kickback rotation of the drill.
- Clean the bit frequently.
- Operate in a location with enough space and be sure you have secure, balanced footing.
- **DO NOT** use your fingers to check the alignment of holes in the work material.
- Prevent whip action by a firm grip on the handle.
- Use the right amount of pressure -- no more, no less -- when pushing on the drill.

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #29

Present PPT Slides #58-#59, *Portable Power Saws and Band Saws*, refer to SG Pg. #29

Portable Power Hand Tools, Cont'd

Portable Power Saws and Bandsaws

Use	Image
Power Saws are most often used in underground work where sawing operations prohibit the use of hand saws or where numerous cuts must be made. Specific applications include: • Wood cutting • Metal cutting The most common type of saw used in underground work is a portable *Sawzall*. This type of saws is driven electrically and is used to cut metal. Some general safety concern related to saws include: • Wear gloves and use eye, face and hearing protection when operating a saw. • **DO NOT** wear loose baggy clothes while operating a saw • Stop all internal combustion generators and compressors when checking and refilling fluid levels (OSHA). • Use approved fire-resistant hydraulic fluids to refill hydraulic reservoirs.	 

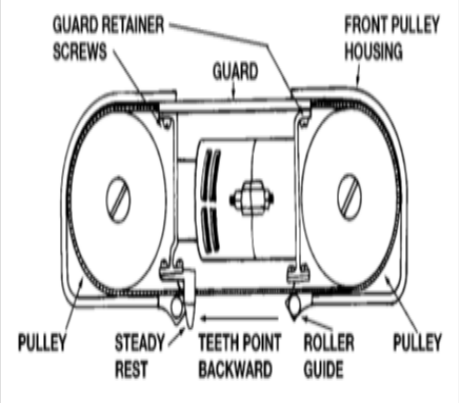
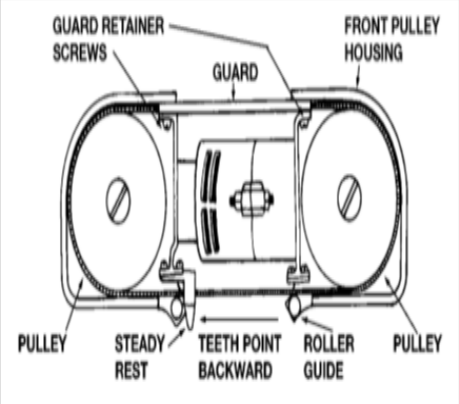
PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #30

Present PPT Slide #60, *Changing Portable Bandsaw Blades*, refer to SG Pg. #30

Portable Power Hand Tools, Cont'd

Changing Portable Bandsaw Blades

Steps	Image
Mentioned below are the steps on how to change blades of a portable Bandsaw: 1. Remove the battery. 2. Turn the handle at the front 180° clockwise until it points forward. 3. **Remove the blade**: a. Lift the blade from the pulley and then from the roller guides. 4. **Install new blade**: a. Examine the new blade for cracks or corrosion. b. Place the new blade between the rollers and face guides with the teeth pointing toward the rear end of the saw. When the teeth point in the opposite direction, turn the blade inside out to reverse it. c. Hold blade in position between the roller guides with one hand and place the blade around the pulleys with the other hand. 5. Turn the tension handle all the way counterclockwise to tighten the blade. 6. Plug in saw and while keeping hands clear of the blade, turn the saw on and off several times to seat the blade.	 

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #31

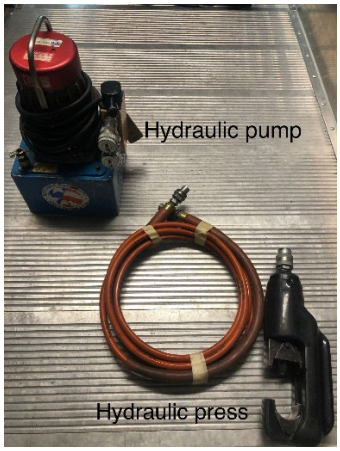
Present PPT Slides #61-#62, *Hydraulic Presses*, refer to SG Pg. #31

Portable Power Hand Tools, Cont'd

Hydraulic Presses

Use	Image
Hydraulic Presses are used to install solderless compression lugs, plugs as well as straight and tee connectors on conductors. The term *hydraulic* refers to the use of a fluid to transfer power from the point at which it is mechanically developed to an application, which in the case of a hydraulic press, is a die which provides a very specific type of compression on a connector.	

Hydraulic Presses, Cont'd

Use	Image
• The dies used by these hydraulic presses can be single compression, which makes a single crimp at a time, or multiple compression type, two or more crimps at a time. • Crimping dies make one or more impressions around the entire circumference of the lug or connector. Indenting dies make impressions at only one point on the lug or connector. • The Construction Standards detail the specific dies and crimps for each job. • Hydraulic presses crimp sleeve connectors to make splices on conductors.	

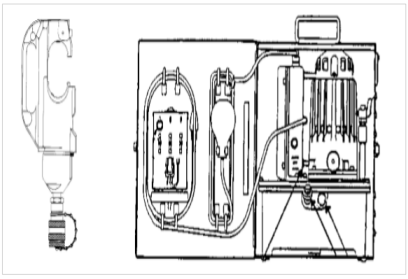
PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #32

Present PPT Slide #63, *Hydraulic Presses, Cont'd*, refer to SG Pg. #32

Portable Power Hand Tools, Cont'd

Hydraulic Presses, Cont'd

Use	Image
Powered Hydraulic Presses have compression forces of up to 60 tons. • These presses use external hydraulic pumps which are connected by hoses and operated remotely by controls on the pump.	
Robo Crimp Presses are battery powered and designed to accommodate all the U - type dies used. • The C- head rotates 180 degrees and can be operated in any position. One person can position, adjust, and hold a connector before crimping. • A squeeze of the trigger generates 12 tons of pressure, and an automatic bypass engages when maximum pressure has occurred. • A gauge is provided to check the splice and ensure that a complete connection is made.	

PORTABLE POWER HAND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #33

Present PPT Slide #64, *Press Care and Maintenance*, refer to SG Pg. #33

Portable Power Hand Tools, Cont'd

Press Care & Maintenence

The following points apply specifically to hydraulic presses all compression tools require some care in handling to keep them in good operating order.

- When **NOT** in use, store the presses and dies in the metal cases provided with the tools,
- Keep the tools clear of foreign substances, particularly grit or sand which may score the pistons or cylinder walls or impede the free movement of the ram.
- Inhibitor compounds, such as Penetrox, contain abrasives which will damage the tools if permitted to remain on the movable parts. Wipe the press clean after using on connections where an inhibitor is used.
- Handle dies carefully to avoid nicking or scoring. After use wipe the dies with an oily rag to prevent rusting.
- The flexible hoses on these presses will withstand operating pressures indefinitely, but they should never be kinked or bent sharply. A 9-inch radius is about as sharp as the hose should be bent while the press is being operated.
- To prevent the possible entrance of air into the hydraulic systems of presses having separate pumps, do not store or use the press with the hose end of the pump in an upward position.
- As in every hydraulically operated mechanism, there will be a small loss of fluid after a period of normal usage. If additional fluid becomes necessary, the press should be tagged with a note explaining the requirement and should be sent into the Tool Room.
- In an emergency, hydraulic tool fluid may be added to the larger presses in the field.

CHECKPOINT #2 - PORTABLE HAND POWER TOOLS - DIRECTIVES

SG Page #34

Present PPT Slide #65, *Checkpoint #2 – Portable Hand Power Tools,* refer to SG Pg. #34

Present PPT Slides #66-#67, *Checkpoint #2 – Portable Hand Power Tools,* refer to SG Pg. #34

Answer Key:

1. False. - Pg. #23 – Power Tool Preparation
2. D. - All the above – Pg. #23 – Power Cord Safety & Testing Steps
3. A & D - Pg. 25 – Hydraulic Tool Handling & Safety
4. False. - Pg. #29 – Portable Power Saws & Band Saws, Cont'd
5. D. - All the above – Pg. #30 – Changing Portable Bandsaw Blades

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Checkpoint #2- Portable Hand Power Tools

Directions Answer each question provided below.

Duration This checkpoint should take ***10 minutes*** to complete.

Questions

1. ***True or False***: It is safe to operate a machine without receiving authorization from PIC.

2. When using electric tools with power cords, take the following steps:
   a. Straighten out the power cord to provide maximum reach
   b. Keep the power cord trailing behind the tool and away from the cutting mechanism
   c. Turn off the tool and check the power cord to see if it is plugged in or check the fuse when the tool suddenly stops.
   d. All the above
   e. None of the above

3. When handling Hydraulic Hoses, you should NEVER:
   a. Bend the hose in a circle with a radius less than 9 inches
   b. Protect the hose from traffic
   c. Allow the tools to do the work
   d. Straighten hose and eliminate kinks prior to charging or pressurizing
   e. All the above

4. ***True or False***: It is completely acceptable to run all internal combustion generators and compressors when checking and refilling fluid levels.

5. When installing a new blade on a saw, you should:
   a. Hold blade in position between the roller guides with one hand and place blade around the pulleys with the other hand
   b. Examine the new blade for damage
   c. Place new blade between rollers and face guides with teeth pointing toward the rear end of the saw
   d. All the above

CHECKPOINT #2 – PORTABLE HAND POWER TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #35

Present PPT Slides #67-#68, *Checkpoint #2 – Portable Hand Power Tools*, *Cont'd*, refer to SG Pg. #35

Answer Key:

6. True. - Pg. #31 – Hydraulic Presses
7. C. - In metal cases provided with tools - Pg. #33 – Press Care & Maintenance
8. True. - Pg. 31 – Hydraulic Presses, Cont'd

Checkpoint #2, Portable Hand Power Tools, Cont'd

Directions Answer each question provided below.

Duration This checkpoint should take 10 *minutes* to complete.

Questions, Cont'd

6. ***True or False***: Hydraulic Presses are used to install solderless compression lugs, plugs, as well as straight and tee connectors on conductors.

7. When not in use, store presses and dies:
    a. On the UG truck
    b. At your desk until needed
    c. In metal cases provided with tools
    d. In tool bags provided with tools

8. ***True or False***: Hydraulic Presses crimp sleeve connectors to make splices on conductors.

UNDERGROUND TOOLS – DIRECTIVES, CONT'D

SG Page #36

Present PPT Slide #69, *Underground Tools*, refer to SG Pg. #36

Present PPT Slide #70, *Underground Tools Overview*, refer to SG Pg. #36

Present PPT Slide #71, *Electric Hydraulic Pumps*, refer to SG Pg. #36

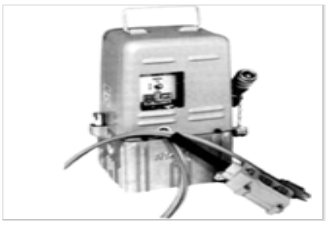
Underground Tools

Underground Tools Overview

In addition to the general-purpose tools included in the *Hand & Power Tool* module, there are several tools (some less portable) that are unique to underground, although not specifically for splicing cable. Those tools are included in the next section.

Electric Hydraulic Pumps

Electric Hydraulic Pumps are used to operate several types of presses and cutters. Electric Hydraulic Pumps have the following characteristics:

Use	Image
• Lightweight and ideal for carrying to any jobsite and requires a 120-volt power supply. • Controlled remotely by a handheld bulb or switch. • Requires only a visual check of the hydraulic fluid level regularly for maintenance. • The Cembre B70M-P-24-KV (black) pump and cutters is the latest battery powered, pneumatic pump operated by a hand controller. • The Cembre B 68M-P18A-KV-RC2 (orange) remote pump and cutters is the latest light weight battery powered remote-controlled hands-free pump and cutter.	 

UNDERGROUND TOOLS – DIRECTIVES, CONT'D

SG Page #37

Present PPT Slide #72, *C Style Presses*, refer to SG Pg. #37

Underground Tools, Cont'd

C Style Presses

Two C Style Presses are used with the hydraulic pumps previously mentioned.

Use	Image
• The larger press head (right) is usually used for 750 to 1500 kcmil cable but accepts all U dies (with an adapter) and can press #8 to 500 kcmil cables. • The smaller press head (below right) is commonly used for terminating transformers with numerous secondary cables and accepts all U dies for cables ranging from #8 to 500 kcmil in size. • Inhibitor compounds, such as Penetrox, contain abrasives that damage the tools if permitted to remain on the moveable parts. Accordingly, always wipe the press clean after making connections the inhibitor.	 

Note: **NEVER** use striking tools to remove dies from any press, as that can damage the dies and press.

Reference the *Hand & Power Tool Part 1* module, to learn more about Hydraulic and Mechanical presses.

UNDERGROUND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #38

Present PPT Slide #73, *Sump Pumps*, refer to SG Pg. #38

Present PPT Slide #74, *Battery Powered Cable Cutter*, refer to SG Pg. #38

Underground Tools, Cont'd

Sump Pumps

When it is not possible to position a truck close enough to use the hydraulics, gasoline, or propane, electrical pumps are also available.

Use	Image
• Another type of water pump used in many areas is the electric model • These pumps are connected to an electric supply of either 120VAC, or 240VAC • They require no priming and are available with a two inch or three-inch discharge hose	

Battery Powered Cable Cutter

Battery powered cable cutters are used to cut CU & AI cable with a gear reduction motor and moveable blade. Cut only specified material for use with the specific tool.

Note: Attempting to cut material not specified for the cutter will result in tool damage and personal injury.

UNDERGROUND TOOLS, CONT'D – DIRECTIVES, CONT'D

SG Page #39

Present PPT Slide #75, *Battery Powered Cable Cutter, Cont'd*, refer to SG Pg. #39

Underground Tools, Cont'd

Battery Powered Cable Cutter, Cont'd

To use the cutter:

1. Select forward or reverse by toggle switch located above the activation switch.
2. Place cable to be cut against the stationary blade and rotate the movable blade around cable by hand to engage into the drive gear.
3. Depress the switch to drive the blade through the cable to be cut. Hold the switch until cable is completely cut.

AMP PROBE – DIRECTIVES, CONT'D

SG Page #40

Present PPT Slide #76, *Amp Probe*, refer to SG Pg. #40

Present PPT Slide #77, *Amp Probe Overview*, refer to SG Pg. #40

Present PPT Slide #78, *Amp Probe*, refer to SG Pg. #40

Amp Probe

Amp Probe Overview

An Amp Probe is an electrical tool used to clamp around an electrical conductor. This tool can be used to measure amperage and voltage, resistance, and continuity etc.

In many situations, the Clamp-on Ammeter or (Split-core) is more suitable for taking current measurements than a multi-meter. Split-core can measure larger current values than a multi-meter can and does not need to be connected to a circuit. A Split-core is simply clamped around a wire when a measurement is taken.

Most Clamp-on ammeters measure AC current only, while other types can measure AC or DC. This is significant because all the equipment you will measure in the field operates on AC.

Amp Probe

An AC clamp-on ammeter uses induction to measure current flow in a wire. This is possible because any time current flows through a conductor, a magnetic field is created. This magnetic field of alternating current changes continually just as the current does many times per second.

The changing magnetic field from one wire can induce voltage in another wire. Within the handle of the meter, the magnetic field from the wire being tested induces voltage in a coil of wire, and this induced voltage can be measured. The greater the current flowing though the wire being measured, the more voltage induced in the coil of the meter.

Some possible uses of the clamp-on ammeter when performing work in the field include:

- Checking load on energized primary cables
- Identifying services at transformer
- Checking load on secondary and individual services
- Identifying current flow on a neutral.

AMP PROBE, CONT'D – DIRECTIVES, CONT'D

SG Page #41

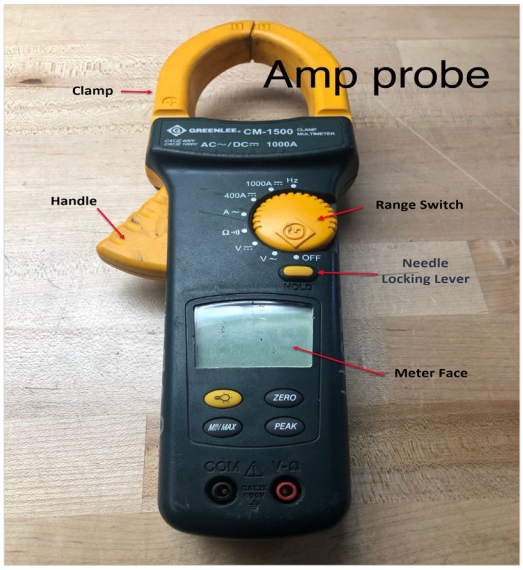
Present PPT Slides #79-#80, *Amp Probe, Cont'd*, refer to SG Pg. #41

Amp Probe, Cont'd

Amp Probe, Cont'd

Let us discuss the major parts of a typical Clamp-on ammeter as shown in the picture below:

1. Handle
2. Clamp
3. Meter face
4. Range selector switch
5. Needle locking lever



Step	Action
1	The **range switch** shown in the image has six ranges, labeled 6,15,30,60,150 and 300 amps.
2	The *meter* reads from zero up to the maximum value listed for each range. For e.g., the 6-amp range is from 0 to a maximum of 6 amps.
3	The **needle locking lever** can be used to keep the needle locked in place after a reading is taken. • This is helpful when the meter must be clamped around a hard-to-reach conductor. In such a situation, the meter face may not be visible when the meter is in position.

AMP PROBE, CONT'D – DIRECTIVES, CONT'D

SG Page #42

Present PPT Slide #81, *Amp Probe, Cont'd*, refer to SG Pg. #42

Amp Probe, Cont'd

Amp Probe, Cont'd

Step	Action
4	A reading can still be taken, however, by using the locking lever to hold the needle in place while the meter is removed from the conductor so that it is face can be seen. The locking lever can also be used to prevent the needle from swinging excessively as the meter is carried from one place to another.

Amp Probe, Cont'd

When using clamp-on ammeters:

- Set it on the highest scale to prevent pegging the needle when an initial reading is taken.
- It is recommended to adjust the scale down from the highest scale to attain a mid-scale reading for an accurate reading.

Most new types of clamp-on ammeters are digital and capable of measuring amperage, voltage, and resistance.

The maximum range for amperage readings is 1000A. To measure voltage and or resistance, a pair of test leads are inserted into the handheld tester. The maximum voltage range is 750 Volts. The Ohm scale is from 0 to 200 ohms and then up to 40 K ohms. The following graphic displays first generation of digital clamp-on ammeters.

VOLTMETER – DIRECTIVES, CONT'D

SG Page #43

Present PPT Slide #82, *Voltmeter*, refer to SG Pg. #43

Present PPT Slide #83, *Voltmeter Overview*, refer to SG Pg. #43

Present PPT Slide #84, *Using a 600 Volt Tester*, refer to SG Pg. #43

Voltmeter

Overview

A Voltmeter is a tool used to measure the current in an electrical circuit. This tool does the same things as the Amp Probe except the amperage.

- Testing for grounded, faulted cable, or associated failures.
- Testing a new cable prior to being placed in service on the distribution system.
- Testing a cable that has been repaired due to a fault or associated failure.

Using A 600 Volt Tester

Let us discuss the procedure to use a 600 Volt Tester.

1. Make a visual inspection of the instrument and check the known voltage.
2. Find or provide bare spots on the conductors for contact points.
3. Make the test, do not stretch leads, scratch contact probes where a questionable or no voltage reading is obtained.
4. Recheck the instrument.
5. Use two devices in series when voltage could exceed 600 volts.

Note: Always check the voltage tester on a source that is known to be energized before assuming that a *no voltage* reading is accurate.

Reference CM-ED-811013-1 – *Lessons Learned – Suggested Procedure Improvement page* to the FAM for Construction & Maintenance and OP-ED-811013 – *Hi-Pot Adapter with Analog Voltmeter Phase Sticks* located on the Management Model

VOLTMETER, CONT'D – DIRECTIVES, CONT'D

SG Page #44

Present PPT Slide #85, *Safety Measures*, refer to SG Pg. #44

Voltmeter, Cont'd

Safety Measures

When operating a Voltmeter:

- Be **AWARE** that a false reading may occur if cables to be tested and presumed dead are in contact with energized conductors or grounds.
- When using a multi-range analog voltmeter phase stick, **select** the proper voltage range.
- All two-stick voltage testers are **NOT** intended for continuous contact.
- ALL two-stick voltage phase sticks are intended for intermittent duty and should be connected only if necessary to obtain a reading.
- **RECORD** steps found to be unclear, missing, inaccurate or incomplete.
- **ENSURE** that the outer surface of the tool is free of all equipment at different potential.

VOLTMETER, CONT'D – DIRECTIVES, CONT'D

SG Page #45

Present PPT Slide #86, *Procedures Guidelines*, refer to SG Pg. #45

Present PPT Slide #87, *Test Procedure*, refer to SG Pg. #45

Voltmeter, Cont'd

Voltmeter Usage Procedures

The voltmeter is used whenever an accurate voltage reading is required on circuits energized at 480 volts or less.

- Each meter has a common terminal and three separate voltage scale terminals, usually 150, 300 and 600 volts.
- Be sure to check each meter as the voltage scales will vary from model to model.
- The voltage scale being read shall correspond to the voltage terminal to which the lead is attached.
- Unless the person operating the meter is certain of the circuit voltage being checked, users shall always start measurements using the highest scale.
- Position the voltmeter on a level surface with the dial face up.
- For older voltmeters, an unleveled meter may give an incorrect reading.
- Connect the leads to the proper voltage scale terminals for the voltage being measured.
- **NEVER** start a voltage test using a lower scale than the voltage expected to be encountered.
- Connect the leads to the circuit or equipment being tested.
- Take the reading.

Voltage Test Steps

Below are the steps to conduct a Voltage Test **(Energized Side to Ground):**

Step	Voltage Test Steps
1	Connect the common terminal lead of the voltmeter to a known ground.
2	Connect the energized side lead to the point at which the voltage is to be measured.
3	Take the reading.
4	If necessary, transfer the energized side lead on the voltmeter to a lower voltage terminal after removing this lead from the energized line. To ensure accurate measurements, always read the lowest scale adequate for the voltage being measured.

VOLTMETER, CONT'D – DIRECTIVES, CONT'D

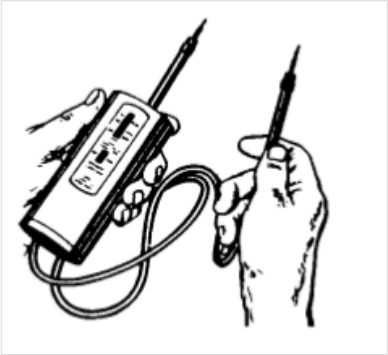
SG Page #46

Present PPT Slide #88, *600 Volt Test Wiggy*, refer to SG Pg. #46

Voltmeter, Cont'd

600 Volt Test Wiggy

The 600 Volt Tester *Wiggy* detects and measures secondary voltages of 600 volts or less.



- The device consists of two insulated leads connected to a metering device that displays the voltage on a needle scale.
- When used within its voltage range this test instrument can also determine an AC or DC voltage source, for paralleling transformers, locate trouble in low voltage installations.

The Wiggy is designed for intermittent use only. Continuous use especially on higher voltages will burn out the solenoid. Before using a 600-volt tester:

- Make certain that the device is correct for the intended job, voltage and working condition.
- Care must be taken to avoid short circuits and grounds.
- Keep hands away from contacts when making tests.

CHECKPOINT #3 – VOLTMETER – DIRECTIVES, CONT'D

SG Page #47

Present PPT Slide #89, *Checkpoint #3 – Voltmeter*, refer to SG Pg. #47

Present PPT Slides #90-#91, *Checkpoint #3 - Voltmeter*, refer to SG Pg. #47

Answer Key:

1. C. - Operate several types of presses and cutters – Pg. #36 – Electric Hydraulic Pumps
2. A. - 2 – Pg. # 37- C Style Presses
3. True. - Pg. #38 – Sump Pumps
4. False. - Pg. #40 – Amp Prob Overview
5. True - Pg. 43 – Overview
6. True. - Pg. #45 – Voltmeter Procedures

Checkpoint #3 - Voltmeter

Directions Answer each question provided below.

Duration This checkpoint should take ***10 minutes*** to complete.

Questions

1. Electric Hydraulic Pumps are used to:
    a. Electrically control pumps
    b. Carry a minimum of 120-volt power supply
    c. Operate several types of presses and cutters
    d. All the above

2. How many C Style presses are used in conjunction with the hydraulic pumps?
    a. 2
    b. 4
    c. 5
    d. 1

3. ***True/False***: When it is not possible to position a truck close enough to use the hydraulics, gasoline, or propane, electrical pumps are also available.

4. ***True/False***: An Amp Probe is not an electrical tool used to clamp around an electrical conductor.

5. ***True/False***: A Voltmeter is a tool to measure the current in an electrical circuit. This tool does the same things as the Amp Probe.

6. ***True/False***: The Voltmeter is used whenever an accurate voltage reading is required on circuits energized at 480 volts or less.

HAND AND POWER TOOLS PART 1 SUMMARY - OBJECTIVES – DIRECTIVES

SG Page #48

Present PPT Slide #92, Hand and Power Tools Part 1 – Objectives, refer to SG Pg. #48

Hand and Power Tools Part 1 Module Summary

Overview

During this module, you learned about the various hand and power tools used to complete various jobs within Underground Construction. Upon review of the material, you will not only be able to correctly identify the power tools used but you will also be able to correctly use them at a jobsite while ensuring PEPCO's safety procedures are always being closely followed.

Objectives

Now that you have completed this module, you are able to:

- Discuss how to safely use general tools and equipment
- Recognize the various portable power hand tools used in UG Construction
- Explain the use for each hand tool used in UG Construction
- Describe how underground tools are used at the jobsite
- Demonstrate how to correctly use an Amp Probe
- Demonstrate how to correctly use a Voltmeter

Topics

In this portion of the training, you were able to gain hands-on experience with:

- General Tools and Equipment Safety
- Basic Hand Tools
- Portable Power Hand Tools
- Underground Tools
- Amp Prob
- Voltmeter

Revision History

Overview

This section identifies the updates that have been made to this Instructor Guide over time, the date significant changes were made, the specific content/content area that was changed and the driver for the change.

Last Revision Date

This module was created on 05-28-2020

Created:	Date: 05. 28. 2020
Author/SME:	Author Name
Manager(s) Approval: *Please specify manager title: Line, Training or Unit*	

Revision History

Refer to the revision history table below to ensure that you are using the most current version of this Instructor Guide.

Revision: #1	Date: 01/01/2022
Author/SME	Author Name
Manager(s) Approval: *Please specify manager title: Line, Training or Unit*	
Reason for Revision:	
What is the Revision:	