AIR FORCE

QUALIFICATION TRAINING PACKAGE (AFQTP)

For

ELECTRICAL SYSTEMS

(3E0X1)

MODULE 24

TOOLS AND EQUIPMENT

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MODULE 24

TOOLS AND EQUIPMENT

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

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AIR FORCE QUALIFICATION TRAINING PACKAGES
for
ELECTRICAL SYSTEMS
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INTRODUCTION

Before starting this AFQTP, **refer to and read the "Trainee/Trainer Guide" located on the AFCESA Web site** http://www.afcesa.af.mil/. This guide will be found at each AFS's AFQTP download page.

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOT revised this AFQTP. If you have any recommendations for improving this document, please contact the Electrical Career Field Manager at the address below.

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Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

MAINTAIN

MODULE 24 AFQTP UNIT 1

HOTLINE TOOLS (24.1.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

HOTLINE TOOLS

Task Training Guide

STS Reference Number/Title:	24.1.1. - Tools and equipment, maintain hotline tools
Training References:	• CDC 3E051B Vol. 1, AFR 32-1064, AB Chance Hotsticks • Electrical safe practices • American National Standards Institute/American Society for testing Materials (ANSI or ASTM) standards.
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• Personnel protective equipment • Hotline tools • Dry tarpaulins • Clean rags • Nonconductive hot-stick pole cleaner • Hot-stick wax • Methyl ethyl kettle (MEK) or acetone • Epoxyglas Bond
Learning Objective:	• Given equipment, maintain hotline tools
Samples of Behavior:	• Identify defects • Follow approved methods to maintain hotline tools • Know safety requirements to maintain hotline tools

HOTLINE TOOLS

Background: Hotline tools can be used in a great variety of jobs on overhead power lines. Used properly, they let you work safely without interrupting power. Only employees who have the necessary training and experience may do live line work using hotline tools and equipment.

The purpose of hotline tools is to minimize the number of power interruptions or outages. The tools are used for maintenance, not for construction. Maintenance of energized, or ”hot,” high-voltage lines may appear hazardous, especially when you compare it with maintenance on de-energized or on low-voltage lines with rubber gloves and other rubber protective equipment. However, the work can be just as safe if linemen are always conscious of the fact that the lines are energized. If you remember this, you’ll be cautious! When you work on live lines, there’s no possibility of the line being hot when you thought it was dead, which is possible when you’re working on *supposedly* dead lines. When you’re working with energized lines, you know that each conductor is hot; each operation is planned and performed accordingly.

Only hot sticks with manufacturer’s certification to withstand this minimum test may be used: 75,000 volts AC per foot for 3 minutes on wooden sticks and 100,000 volts AC per foot for 5 minutes on fiberglass and epoxy sticks. Efforts should be made to replace all wooden hotline tools with fiberglass. When a hotline tool is received, you assume a certain degree of responsibility for its continued safe condition. Epoxyglas hotline tools are safe, dependable, and made to take demanding use.

To perform this task, follow these steps:

Care of hotline tools.

- To get peak tool performance and ensure safety, follow these basic guidelines in storing, transporting, and handling tools.

Step 1: Store tools in bins or on racks, and set aside trailers or special areas on trucks for tool transport.

Step 2: Always make sure tools are dry. Long exposure to moisture, dirt, or ultraviolet attack can affect the tool adversely.

Step 3: On the job site, place tools on portable racks or lay them on clean, dry tarpaulins or plastic sheeting.

Step 4: Wipe all tools with a clean cloth before sending them up the pole.

Step 5: Avoid rough handling, such as banging the tools against the pole or other hardware as they are raised and lowered.

Step 6: If it starts to rain, wipe the tools dry before storing them.

Hotline tool inspection.

Step 1: Initially, all wooden hotline tools must be tested for moisture level on receipt from the manufacturer and re-tested at least every 6 months or when moisture penetration is suspected.

Step 2: Hotline tools must be inspected before each use.

Step 3: Inspect the tool visually for cracked or distorted end fittings, feathered rivets or ferrules that have moved visibly, hairline cracks or scars in the insulation, and blisters in poorly applied coatings that could trap moisture.

Step 4: Hotline tools are tested electrically upon receipt from the manufacturer and retested every 6 months.

Step 5: The electrical supervisor inspects the tools visually in the field at least every 6 months to make sure they're maintained properly.

Step 6: Hotline tools stored for mobility are tested once a year.

Step 7: The supervisor keeps a record of the field inspection date and the 6-month moisture level and electrical test dates.

NOTE:
The record must include the next due date for field inspection, moisture, and electrical test.

Cleaning fiberglass tools.

- Inspect the fiberglass surface of each tool for dirt, creosote, grease, or any other foreign material before and after each use. If you find any of these contaminants, the fiberglass surface must be cleaned. This cleaning process must involve as many of the steps below as are needed:

Step 1: Wipe the fiberglass with a clean rag.

Step 2: Clean the fiberglass surface with hot-stick pole cleaner.

- If Step 2 fails to clean the fiberglass surface (this should be infrequent), take the tool out of use, tag it, and refer it to the supervisor for further evaluation.

NOTE:
Don't write on the fiberglass surface.

- Don't use household or industrial soap detergents, abrasives, and cleaners (liquid or powdered form) to clean fiberglass tools under field conditions. Cleaning agents leave conductive residue unless they're rinsed off with generous amounts of water (usually not available in the field). Abrasive cleaners destroy the surface gloss on the stick. All fiberglass tools that are subjected to such cleaning agents must be tested electrically to ensure complete removal of residue from soap-type cleaners.

NOTE:
Don't use this cleaner on painted surfaces. This nonconductive cleaner will also remove surface wax on fiberglass. If Step 2 is successful, Step 3 is a must procedure.

Step 3: Wax the fiberglass surfaces with hot-stick wax.

- Waxing the fiberglass surface of hot-line tools not only protects the glossy surface of the fiberglass, but also adds to the tool's electrical integrity. Wax provides a protective barrier against foreign substances such as dirt and creosote (which is easily removed

with hot-stick pole cleaner). Waxing isn't necessary after every use of the tool, but rather as needed to maintain a glossy surface.

NOTE:
Wax must be applied after every cleaning with hot-stick pole cleaner.

- Use only hot-stick waxes recommended by the hotline tool manufacturer.
- Silicone cloths may enhance the electrical integrity of hot sticks and help protect the glossy fiberglass surface, but they're not approved for use because silicone may migrate and over a period of time may hamper refinishing. Hot-stick wax has all of the advantages of silicone without the suspected adverse effects.

Hot-stick repair.

Step 1: To completely clean and restore fiberglass, remove the old glass by sanding.

Step 2: Wipe the pole clean and refinish with fresh Epoxyglas Glass Restorer.

Step 3: The coating will dry in a few hours, and the tool should be ready for use within 24 hours, but only after an application of hot-stick wax.

Step 4: Small ruptures in the insulation part of the tools can usually be repaired at the shop by removing the damaged fibers, cleaning the void with methyl ethyl kettle (MEK) or acetone, and applying the Epoxyglas Bond.

Step 5: After the patch has set, apply Epoxyglas Glass Restorer.

Step 6: When you're using MEK for this process, you must provide adequate mechanical ventilation or personnel protective equipment.

NOTE:
Consult the Material Safety Data Sheet (MSDS) before each use.

SAFETY:
A TOOL THAT SHOWS SIGNS OF MAJOR DAMAGE SHOULD BE DESTROYED OR RETURNED TO THE FACTORY FOR EVALUATION AND POSSIBLE REPAIR.

Hot-stick test.

Step 1: Clean and wax all hot sticks before electrical testing by people who are thoroughly familiar with hi-pot test equipment and procedures. AC testing according to manufacturer's specifications is permitted instead of the DC testing specified below. Be sure to observe the safety precautions in the test set instruction manual and the section.

Step 2: Rope off the test equipment and test specimen to guard against accidental contact by people in the vicinity.

Step 3: Sticks may be tested electrically using a DC hi-pot test set (Figure 1). See Figure 1 for typical set-up for test.

- Four 1-foot segment tests and one overall test are made on each stick. In some cases, test segments may overlap.
- The test contacts must be two spiral springs, 5/8 inch to 1 inch in diameter, or clamps that make contact with the entire circumference of the stick. Springs must be wound of spring steel, 40 thousandths of an inch in diameter (±5 thousandths).

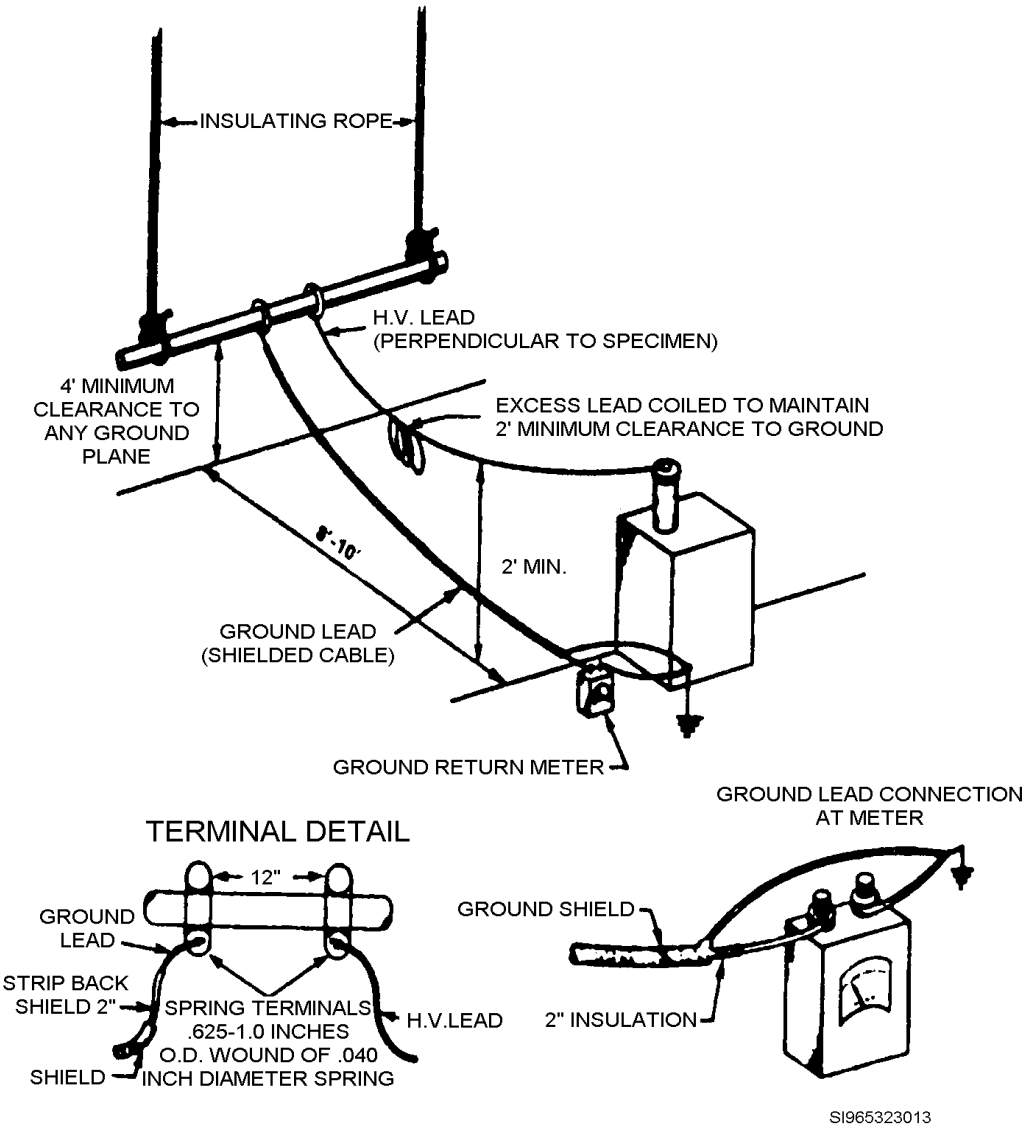


Figure 1, Typical set-up for high-voltage tests

Step 4: Suspend the stick in a horizontal position with clean polypropylene insulating rope about 4 feet above the floor.

Step 5: Place the DC test set on the floor 8 to 10 feet perpendicular distance from the center of the stick.

Step 6: Wrap the springs around the stick so spring contact is maintained on the entire circumference of the stick. (These springs may have to be shielded to reduce corona losses.)

Step 7: Attach the test leads to the springs so that sharp edges are inside the springs. The hot lead of the test set must be routed directly from the top of the test set resistor to the nearest test spring. Coil the excess lead in the center of the lead maintaining 2 feet ground clearance. Bag this connection with a plastic bag heavy enough to eliminate corona. Use shielded cable, similar to RG–58, for ground lead. Attach the inner conductor of the shielded cable to the ground spring and to ground return meter of the test set. Strip back 2 inches of the shield and float the shield on the spring end and attach the shield to the ground lug on the test set.

Step 8: Apply potential to the test segment. Increase the voltage gradually (10k per second) to 80 kV and maintain for 1 minute. Read the maximum leakage current in the ground return meter. A leakage in excess of 8 microamps (µA) signifies a failure of any test segment. Test the other three segments the same way as the first and record the four leakage current readings. Refinish any stick that fails the segment test and retest the stick.

Step 9: Reconnect the test leads to apply 100 KV DC for 1 minute to the full length of the stick. A leakage current above 10 µA indicates an internal contamination problem and signifies a failure. Internal operating rod shotgun sticks and other hollow fiberglass sticks that fail the overall test must be recleaned internally and retested.

Optional hot-stick test.

Instead of the procedure we just listed, a trade name hot-stick tester (A. B. Chance LS–80) may be used every 6 months. Follow the manufacturer's instructions. Hot-line sticks also may be tested by contract according to The American National Standards Institute/American Society for Testing Materials (ANSI or ASTM) standards.

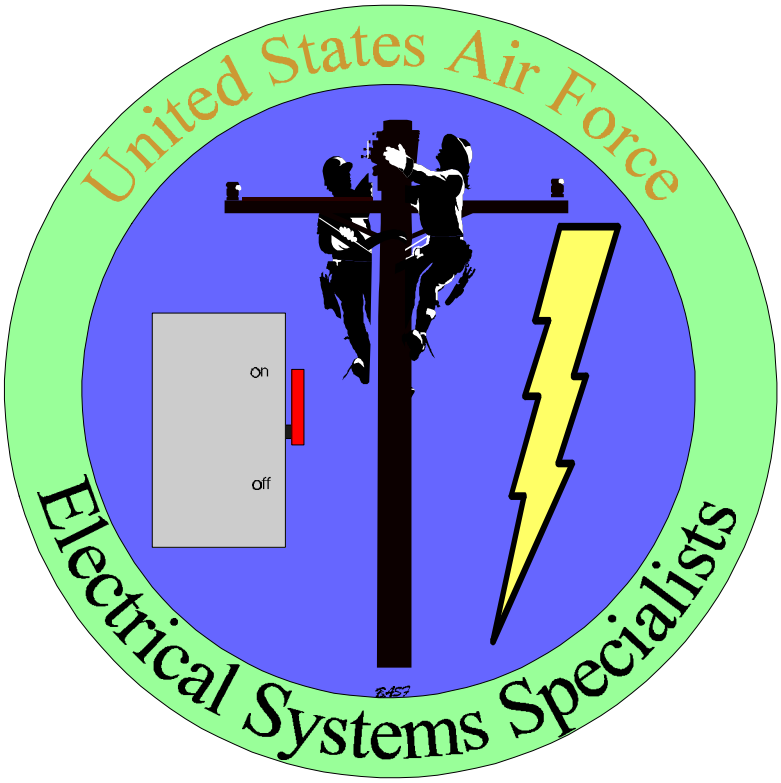
Review Questions for Hotline Tools

Question	Answer
1. The purpose of using hotline tools is to minimize the number of power interruptions or outages.	a. True b. False
2. Where should hotline tools be stored?	a. In bins or on racks b. In bins or leaning on walls c. Leaning on walls in a vertical position. d. Lying on racks or on floors.
3. Silicone cloths are not used to protect the glossy finish of fiberglass hotsticks because they _____.	a. Dull the glossy finish b. Hamper the refinishing process c. Inhibit the electrical integrity of the stick. d. All of the above.
4. How often are hot line tools tested electrically?	a. Every 2 years b. Every 3 months c. Every 6 months d. Annually
5. How often do hot sticks require a moisture test?	a. Every 2 months b. Every 3 months c. Every 6 months d. Only when moisture is suspected

HOTLINE TOOLS

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee explain the proper care of hot line tools?		
2. Did trainee do all necessary steps during inspection?		
3. Did trainee properly clean hot line tools?		
4. Can trainee explain the test procedures using hi-pot test equipment?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



MAINTAIN

MODULE 24 AFQTP UNIT 1

RUBBER PROTECTIVE EQUIPMENT (24.1.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

RUBBER PROTECTIVE EQUIPMENT

Task Training Guide

STS Reference Number/Title:	24.1.2. – Tools and equipment, maintain rubber protective equipment
Training References:	• AFR 32-1064, AB Chance Hotsticks • Electrical safe practices • CDC 3E051B Vol. 1 • ANSI/ASTM
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Rubber gloves • Rubber sleeves • Rubber blankets
Learning Objective:	• Given equipment, maintain rubber protective equipment
Samples of Behavior:	• Follow approved methods to maintain rubber protective equipment • Know safety requirements associated with care and maintenance of rubber protective equipment
Notes:	
• Any safety violation is an automatic failure.	

RUBBER PROTECTIVE EQUIPMENT

Background: Electrician's rubber protective equipment is for personal protection, and serious personal injury may result if it fails in use. The American National Standards Institute/American Society for Testing Materials (ANSI/ASTM) specifications for in-service care of rubber protective equipment stress visual inspection in the field as an important requirement in protecting from electric shock. Rubber protective equipment made of Type I natural or polyisoprene synthetic rubber is subject to ozone and corona deterioration. Salcore equipment made of Type II elastomeric compounds is not affected by this particular deterioration. Your rubber protective equipment may be subject to chemical deterioration and possible loss of insulating properties after prolonged exposure to ozone, heat, sun, oil and grease, or general weathering. Therefore, in addition to regular electrical tests and visual inspection for physical defects such as holes, tears, punctures and cuts, it should also be visually inspected at regular intervals for such signs of possible chemical deterioration as corona cutting, ozone or sun checking, texture changes such as swelling, softening, hardening, or becoming sticky or inelastic. Because of potential loss of electrical resistance due to reversion or other deterioration, equipment should be withdrawn from service upon the first indication of chemical deterioration.

The protective equipment is manufactured and color code labeled in conformance with applicable ANSI/ASTM specifications that include maximum use voltages and in-service inspection and retest requirements. Specifications for rubber protective equipment are:

ANSI/ASTM D120 Rubber insulating gloves.
ANSI/ASTM D178 Rubber insulating switchboard matting.
ANSI/ASTM D1048 Rubber insulating blankets.
ANSI/ASTM D1049 Rubber insulating insulator covers.
ANSI/ASTM D1050 Rubber insulating line hose.
ANSI/ASTM D1051 Rubber insulating sleeves.
ANSI/ASTM F478 In-service care of insulating line hose and covers.
ANSI/ASTM F479 In-service care of insulating gloves and sleeves.

NOTE:
ASTM publication PCN#06–411001–20, ASTM *Specifications for Electrical Protective Equipment for Workers*, is a compilation of all specifications in one booklet. Copies of individual specifications and the booklet may be obtained from ASTM, 1916 Race St., Philadelphia PA 19103.

The in service specifications require that rubber gloves and sleeves must be electrically tested initially upon receipt from the manufacturer and retested at least every three months for rubber gloves (shelf life 12 months), and 12 months for rubber sleeves. A visual field inspection should be also made by the exterior electrical supervisor to determine whether the gloves and sleeves are being maintained in satisfactory condition. This inspection should be made every 6 months.

Suggested issue.
Each worker should be equipped with a pair of insulating rubber gloves, leather protectors sized to match, a glove bag to carry and store them, and a squeeze bottle of dusting powder.

An extra pair of gloves is required for a retesting program, which would leave you with one set of gloves while the other set is tested.

Sizes.

Rubber gloves are made in hand sizes 9 through 12. Finding the right size will probably involve a little trial and error and some work experience. Gloves a little too small are tough to take off; gloves a little too big will cost you some dexterity. Lengths are 11 inches and 14 inches for low secondary voltages; 14, 16, and 18 inches for primary voltages.

Leather protectors or gauntlets.

Leather protectors should be 2 to 5 inches shorter than rubber glove length, depending on the maximum voltage use. Although clean and dry leather protectors aren't good conductors, they don't have the insulation value of the rubber glove—thus the reason for the shorter length. Leather protectors match gloves size for size.

Glove bag.

Glove bags should be 2 inches longer than the rubber gloves. You don't want your gloves in a bag that's too small; they would bend and develop weak areas, possibly breaking down the insulation.

Rubber sleeves.

Rubber sleeves come in regular, large, and extra large sizes. The choice depends on the size of the person or the maximum amount of clothing worn in cold weather. Rubber sleeves are tucked into the rubber gloves, leaving continuous protection to your shoulder. To check the fit, stretch your arms; the sleeves should stay inside the rubber gloves.

Cotton gloves and powder.

You can wear short cotton gloves inside the rubber gloves during cold weather. Dusting powder soothes your hands and helps prevent sticking when you remove the rubber gloves.

Contact with petroleum-based products.

If contact has been made with any petroleum-based products (such as inhibitors, hydraulic fluids, and transformer oils), the gloves and sleeves must be wiped off with a rag as soon after the contact as possible. Failure to remove the petroleum-based product promptly will result in the rubber's swelling and ultimately deteriorating. The swelling will eventually disappear, but it may cause considerable reduction of mechanical strength and possible chemical deterioration at the point of swelling.

When to don rubber gloves.

Rubber gloves are the basic protection from electric shock, because the hands are the most likely part of the body to make initial contact with energized parts. For rubber gloves to provide protection, you should put them on before you're in a position where you might reach or fall into energized lines or equipment.

Rubber blankets.

Both Type I, natural or polyisoprene synthetic rubber and Type II, Salcore elastomeric compound blankets are subject to damage by petroleum-based products. As it is with rubber gloves and sleeves, prompt removal of the petroleum-based products is important to eliminate

or reduce possible swelling and damage to the blanket. Depending on the type of petroleum-based product involved in the contact, the area affected can become spongy and discolored. Blankets damaged by petroleum products should be mutilated and discarded. Rubber blankets must be inspected carefully before each use.

NOTE:
If swelling occurs and eventually goes down, the mechanical strength—that is, the resistance to snag, puncture, and tear—may be greatly reduced and chemical deterioration may result.

In-service blanket specifications.

In-service specifications require that rubber blankets must be tested electrically upon receipt from manufacturer and retested at least once a year. In addition to the electrical test, a visual inspection of blankets should be made in the field by the electrical supervisor to see that the blankets are being kept in satisfactory condition by the users. These inspections should be at intervals no longer than 6 months.

In-service specifications.

In-service specifications require that rubber line hose, hoods, and covers be tested electrically upon receipt from the manufacturer and retested at least once a year. At least every 6 months, the electrical supervisor must make a visual inspection of line hose, hoods, and covers to be sure the users are maintaining them in satisfactory condition. Individual users should make frequent field inspections. Type I line hose, hoods, or covers should not be left in service or energized any longer than necessary. Extended exposure may result in ozone checking, corona cutting, or excessive weathering.

Rubber goods stored in vehicles.

Each bucket truck and line maintenance truck must be equipped with ample rubber and other protective equipment normally required. This protective equipment must be further supplemented by such rubber goods as the electrical superintendent considers desirable for carrying on the work with safety. Those rubber goods must be carried in an approved container, either built in or not, which will protect them from moisture, heat, light, and mechanical injury.

NOTE:
If this container is metal, the rubber goods should be kept from contact with the metal.

Inspection record.

- The electrical supervisor must maintain a record showing the field inspection date and the electrical test date of all rubber and other protective equipment.
- This record must also include the next due date for field inspection and electrical test.

To perform the task, follow these steps:

Sleeve inspection.

Step 1: In inspecting sleeves, inspect the entire inner and outer surface for pinholes, cuts, scratches, abrasions, aging, corona cutting, oil markings, or other chemical injuries.

Step 2: Stretching or rolling the rubber between your fingers or on a flat surface will help reveal defects.

SAFETY:
IF ANY OF THE ABOVE DEFECTS ARE FOUND, THE SLEEVE MUST BE TAGGED AND WITHDRAWN FROM SERVICE.

Blanket inspection.

Step 1: To locate swelling, scratches, tears, abrasions, snags, tracking cutting, or age cracking, roll the blankets twice on each side, with the second roll at a right angle to the first roll.

Step 2: Blankets that show any of the flaws we just listed must be removed from service.

Blanket storage.

Step 1: Blankets must always be stored flat or rolled in blanket rollups or canisters. They must never be folded, creased, or compressed in any way.

NOTE:
Don't use any kind of tape to keep the blankets rolled; the adhesive can damage the blanket surfaces.

Rubber insulating line hose, hoods, and covers inspections.

Step 1: Rubber insulating line hose, hoods, and covers must be inspected before each use.

Step 2: Inspect thoroughly for cuts, scratches, corona cutting, holes, tears and punctures, rope or wire burns, and aged rubber. Also, look for texture changes such as swelling, softening, hardening, becoming sticky or inelastic, which are signs of chemical deterioration.

SAFETY:
IF THE MECHANICAL DAMAGE EXTENDS ONE-QUARTER OF THE WALL THICKNESS OF THE HOSE OR HOODS OR IF THERE IS POSSIBLE CHEMICAL DETERIORATION, THEY MUST BE REMOVED FROM SERVICE.

Step 3: Line hoses, hoods, and covers must be wiped clean of any petroleum-based product or other damaging substances as soon as practicable after contract.

Step 4: They should be stored in a relaxed position, that is, without distortion and mechanical stress.

NOTE:
Don't use tape to secure line hose, hoods, or covers for shipping or storage.

Rubber Glove Inspection.

- Electrician's rubber gloves must be carefully inspected before each use. Rubber gloves must be field air-tested before use each day, and more frequently if there is cause to suspect damage.

Step 1: Stretch the rubber and look for cracks, tears, and holes in the gloves especially around the parts of the glove that bend when your hands flex.

Step 2: Gloves must be inspected inside and out.

Step 3: To perform a field air test, hold the glove with the opening up and quickly roll the cuff trapping air inside the glove.

Step 4: Hold the glove close to your face, squeeze it and listen for air escaping and try to feel air on your cheek.

SAFETY:
ANY DAMAGED GLOVE IS TO BE REMOVED FROM SERVICE AND DESTROYED.

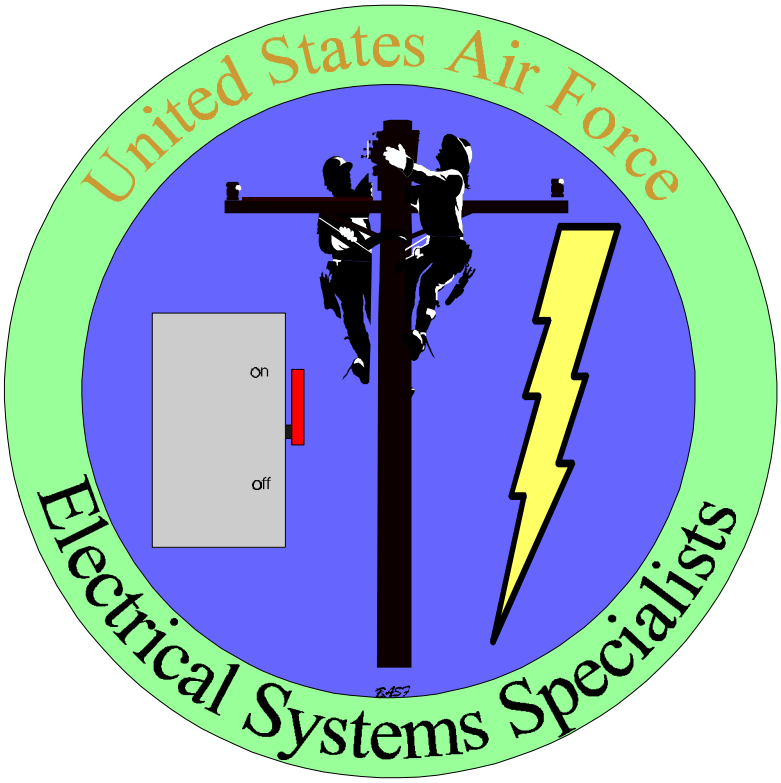
Review Questions
for
Rubber Protective Equipment

Question	Answer
1. What problem would you most likely encounter with rubber gloves that are a little too big for your hands?	a. Tough to take off b. Excessive sweat c. Loss of dexterity d. All of the above
2. How are rubber sleeves worn in conjunction with rubber gloves?	a. Rubber gloves are tucked in to sleeves b. Rubber gloves are butted up to sleeves c. Rubber sleeves are tucked into gloves d. None of the above
3. How often must rubber gloves be field air-tested?	a. Daily b. Monthly c. Before each use d. Before each use and more often if problem is suspected
4. How are rubber sleeves stored?	a. Folded in truck bins b. Sleeve Bags c. Rolled up d. Both B and C
5. What are the items to look for in inspecting a rubber sleeve?	a. Pinholes, cuts b. Scratches, abrasions c. Oil markings, chemical injuries d. All of the above
6. When locating defects in blankets, roll them twice on each side so that the second roll is at a 60-degree angle to the first.	a. True b. False
7. What must be done if you find a petroleum product on a rubber blanket?	a. Wash with soap and water b. Wipe of immediately c. Scrape off with a piece off wood d. Wipe off on rounded truck frame

RUBBER PROTECTIVE EQUIPMENT

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee perform proper field inspection on sleeves?		
Can trainee perform proper field inspection on blankets?		
2. Can trainee perform proper field inspection on line hose, hoods and covers?		
Does trainee know proper storage practices for rubber protective equipment?		
Can trainee perform proper field inspection on rubber gloves?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



MAINTAIN

MODULE 24 AFQTP UNIT 1

CLIMBING EQUIPMENT (24.1.7.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

CLIMBING EQUIPMENT

Task Training Guide

STS Reference Number/Title:	24.1.7. – Tools and equipment, maintain climbing equipment
Training References:	• CDC 3E051B Vol. 1 • Electrical safe practices • AFR 32-1064 • The Lineman's and Cableman's Handbook 8 Third edition • Federal Specification KKB-151, Belts, Lineman's Safety Leather, and with subpart 1926.959 (Lineman's Body Belts, Safety Straps, and Lanyards) of OSHA standards.
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• Climbing equipment • Neutral soap • Neatsfoot oil • Gaff gauge • File • Cleaning cloth.
Learning Objective:	• Given equipment, maintain climbing equipment
Samples of Behavior:	• Identify defects in climbing equipment • Follow step by step procedures to maintain climbing equipment • Know safety requirements to maintain climbing equipment

CLIMBING EQUIPMENT

Background: Pole climbing is necessary in constructing and maintaining over 600V electrical systems. The climbing part of overhead work isn't difficult or hazardous if you are careful in selecting, fitting, and maintaining your climbing equipment.

Only the best grade, smooth, pliable harness leather or other material approved and conforming to government specifications should be used in body belts, safety straps, and climber straps. All electrician's belts must conform to Federal Specification KKB–151, *Belts, Lineman's Safety Leather*, and with subpart 1926.959 (Lineman's Body Belts, Safety Straps, and Lanyards) of OSHA standards.

Safety inspections and tests. Personal climbing equipment must be inspected before each use, and the supervisor should inspect body belts and safety straps in conjunction with the regular tool inspection (every 6 months). If faulty conditions are found or suspected, the articles involved must be repaired or replaced at once.

Belts made of webbing. Webbing offers some advantages over leather and should be considered. Here are some of the advantages of web belts:

- Webbing is superior for any safety belt that may have to take an impact load.
- Webbing has three to four times as much resistance to impact loading as the same size leather belt.
- The leather belt width has no effect on its strength at the buckle.
- Leather takes special care and treatment to retain its strength; webbing doesn't.
- Only a leather expert can tell by visual inspection with any accuracy the condition and strength of leather. Webbing can be judged more accurately by visual inspection.

How to use and store climbers. The precautions for using, storing, and transporting climbers are:

- Accidents resulting from pole climbing can be reduced if a few simple rules are applied. Although most cutouts are due to improper climbing techniques, a large number are due to improper care and maintenance of climbers. Well cared for climbers are safer and also reduce fatigue. Each worker must be equipped with a pair of properly adjusted climbers, and should not use another's.
- Stored climbers should be wrapped in pairs and fastened with their straps.
- Treat the leather straps with Neatsfoot oil to keep them pliable and soft. Inspect straps frequently and keep them in good condition at all times. Immediately replace straps that can't be repaired properly.
- Use of pads is suggested, but they must be kept in satisfactory condition and replaced when they become worn.
- In climbing poles, workers must be careful to put the gaffs only into sound wood and to avoid all knots, loose wood, checks, cracks, decayed spots, nails, ground wires, and similar hazards.
- Ice- or sleet-covered poles require special care to seat the gaffs in the wood securely.
- A worker using climbers on a pole must be careful to avoid injury to others working nearby. Climbers must be inspected before each use to detect nicked or dulled cutting edges on the gaff. Check them immediately if damage is suspected after striking them against hard objects such as pole hardware or nails.

To perform these tasks, follow these steps:

Clean and dress leather. The recommended method for cleaning and dressing body belts and safety straps is to:

Step 1: Body belts and safety straps should be cleaned and dressed every 3 months and more often if they get wet from rain or perspiration. Wipe off all surface dirt with a dampened (not wet) sponge.

Step 2: Rinse the sponge in clean water and squeeze it nearly dry, then work up a creamy lather with neutral soap (free from alkali), such as castile or white toilet soap.

Step 3: Wash the belt or strap thoroughly with the lathered sponge to remove embedded dirt and perspiration. Remove any excessive moisture by wiping dry with a cloth.

Step 4: Work up a lather of saddle soap the same as with neutral soap.

Step 5: Work the saddle-soap lather well into all parts of the leather. Place the leather in shade to dry.

Step 6: When the leather has practically dried, rub it vigorously with soft cloth.

Step 7: When you're using it in connection with painting, carefully remove the paint with dry cloth as soon as possible.

NOTE:
If leather can not be made soft and pliable by using saddle-soap dressing, it should be oiled.

Oil leather. Body belts and safety straps usually require oiling about every 6 months

Step 1: Clean the leather with neutral soap.

Step 2: While it's still damp, apply about 1/4 ounce or 2 teaspoonfuls of Neatsfoot oil (or other suitable animal or vegetable oil) gradually with hands or rag, using light strokes to work it into the leather. Be sure light, even distribution is made. To avoid injuring leather, never flush the oil on directly. Don't use mineral oils or greases such as machine oil or Vaseline. Leather should never look or feel greasy, an indication of excessive oil. Too much oil stretches leather and may pick up sand or grit.

Step 3: After oiling, set the belt or strap aside in a dry place for about 24 hours to let the leather dry slowly.

Step 4: Rub it vigorously with a soft cloth to remove excess oil.

Store leather. Follow these precautions in storing body belts or safety straps:

Step 1: If they're insufficiently oiled, oil them before placing them in storage.

Step 2: Oil them at least once every 6 months in storage.

Step 3: Never store leather goods with sharp-edged tools. When belts or straps are in the same compartment with climbers, avoid the possibility of cutting or puncturing leather with gaffs.

Step 4: Never store them where they may be subjected to excessive heat or dampness.

Visually inspect body belts:

- Inspection must include the following:

Step 1: Check leather loops and holding D-rings that are worn or crushed enough at edges to affect strength or cause the leather to tear.

Step 2: Loose or broken rivets, particularly those in loops holding D-rings.

Step 3: Cracks and cuts tending to tear the leather or affect belt strength.

Step 4: Hard, dry leather.

Step 5: Broken or torn tool pouch.

Step 6: Broken or defective buckle.

Step 7: Burnt leather.

Step 8: Torn or badly damaged hole for the buckle tongue.

NOTE:
Burnt leather is dry on the outside. Bending it at the burnt spot cracks the leather and you can easily remove small pieces between the cracks with a fingernail.

Visual inspection of safety straps (include looking for):

Step 1: Cracks, cuts, nicks, and tears (particularly across or on the edges of the strap) that tend to affect strength.

Step 2: Loose, worn, steel reinforcing the strap.

Step 3: Hard, dry leather.

Step 4: Broken or defective snaps or poor action of the tongue on the snap (The tongue is the moving part of the snap). The tongue should work freely without side play and close securely under the spring tension.

Step 5: Broken or defective buckle.

Step 6: Torn holes for the tongue of the buckle.

Step 7: Wear-thinned leather. If it's otherwise sound, the strap may be used if it's at least 1/8 inch thick at every point where it's not doubled. In the doubled area, the leather may wear slightly less than 1/8 inch thick.

Step 8: Burnt leather.

Step 9: Grain (smooth side of leather) worn so that fibers are plainly visible.

Bending test for leather.

Step 1: Before the bending test on a body belt or safety strap, make sure the leather has enough oil to be soft and pliable. After the test, the leather should show no cracks other than slight surface cracks.

Step 2: Bend the safety straps with the grain (smooth) side out over 3/4-inch mandrel. Test over the entire strap.

Step 3: Make a similar test for body belts wherever they can bend, such as under tool loops and at tongue strap.

SAFETY:
DON'T BEND BELTS OR STRAPS SHARPLY OVER TOO SMALL A MANDREL BECAUSE EVEN GOOD LEATHER MAY DEVELOP CRACKS IF EXCESSIVE STRAIN IS PUT ON THE GRAIN LAYER.

- **Inspect climbers:** Perform this task upon receipt of the climbers and at least weekly thereafter.

Step 1: Inspect the climbers, associated straps, and pads for:

- Loose gaff.
- Nicks and depressions in the gaff.
- Ridge of gaff for alignment.
- Dull gaffs.
- Broken or distorted gaff points.
- Broken or loose leg or foot strap loop.
- Excessively worn, cracked, or torn straps and pads.
- Enlarged buckle holes in the straps.
- Broken or damaged strap buckles.

- Fractured or cracked leg irons and stirrups.
- Excessively worn stirrups.
- Fractured leg iron sleeves.
- Broken or loose rivets and screws on sleeves and straps.
- Defective strap rings.
- Broken or damaged loop clip-on straps.
- Gaff guards in poor condition.
- Improper length of gaffs.
- When any of these conditions can't be repaired readily, new climbers, pads, or straps must be secured.
- Wash the belt or strap thoroughly with the lathered sponge to remove embedded dirt and perspiration.
- Remove any excessive moisture by wiping dry with a cloth.
- Work up a lather of saddle soap the same as with neutral soap.
- Work the saddle-soap lather well into all parts of the leather.
- Place the leather in shade to dry.
- When the leather has practically dried, rub it vigorously with soft cloth.

NOTE:
When you're using it in connection with painting, carefully remove the paint with dry cloth as soon as possible.

Maintain climbers.

- You can restore damaged or dull gaffs to original shape by filing and honing. If gaffs can't be restored, replace them. There are three ways to tell whether gaffs are sharpened properly.

Step 1: How to maintain climbers (Gauging).

- This method checks the gaff's length, width, and thickness and the profile of its point. Reference lines are scored on the gauge with slots provided to tell whether the gaff length is satisfactory. Most gauges also provide a contour test to tell whether the point is curved properly. Openings are provided to tell whether the point is too keen. Each manufacturer makes a gaff gauge for their climbers, so the gauges aren't interchangeable. Always use the manufacturer's instructions if they're available.

Step 2: How to maintain climbers (Plane test).

- This method may be used with the gauge or independently if the gaffs are sharpened by machine. The test is made by using a soft board to tell whether proper sharpness has been reached. Place the climber with the gaff side down and parallel to the board without applying downward pressure above the gaff. Push the climber along the board. If the gaff is properly contoured and sharpened, it will dig into the wood and hold within approximately 1 inch. If the climber continues to glide along the board for more than 1 inch, it needs more honing.

Step 3: How to maintain climbers (Pole cutout).

- After the climbers have been machine sharpened or gauged (and as often as required thereafter), the gaffs may be tested on a pole. To do this, put on the climber to be tested with only the foot strap fastened, and place the hand between the leg and the pad with palm toward the pole. With the leg at a 30° angle, jab the gaff about one-fourth inch (in depth) into the pole, about 1-foot above ground level. Then you must apply enough pressure downward on the climber to hold the gaff into the pole and maintain the same penetration. While in this position, use the other hand to maintain balance and move the knee toward the pole until the strap-loop of the leg iron rests against the pole. Gradually exert pressure (straight downward) with the foot still maintaining pressure against the pole with the knee. A properly sharpened and shaped gaff will cut into the pole and hold within 2 inches.

Step 4: How to sharpen climbers.

- Honing gaffs with a pocketsize, smooth carborundum stone is all that is necessary for a machine-sharpened climber. If gaffs can't be restored to satisfactory condition with a hone in a short period of time, they must be returned for sharpening or replacement. The shortest length of gaff permitted is 1 and 1/4 inches as measured on the undersides. (The average life of a pair of climbers is 5 years or by the time both gaffs have been replaced twice.) If gaffs aren't machine sharpened, you'll need two tools to field sharpen them: a file and pocketsize fine-grit carborundum stone. The file should either be a bastard mill file or a standard smooth file. For sharpening the gaff to proper thickness, file the metal from the flat inner-side of the gaff. Take care to keep from notching the leg irons or stirrup. Use forward motions, toward the point and down to edges of the gaff's underside. Don't allow rocking motions of the file, because this will round the edges of the gaff.

  After you get the right thickness, the underside of the gaff should be straight to within one-sixteenth inch of the point, then rounded slightly toward the ridge of the gaff on a radius of one-fourth. You can get additional sharpness after filing by dressing the underside and rounded part of the gaff with the honing stone. Use the stone to remove any burrs along the edges, but never file the gaff's outer ridge. To get the right width, you can use the file on the rounded part. Use strokes following the gaff's contour. Use gaff guards to protect the gaffs when the climbers aren't being used and when other tools and materials are stored or transported along with the climbers.

NOTE:
Climbers must never be stored or transported without appropriate gaff guards.

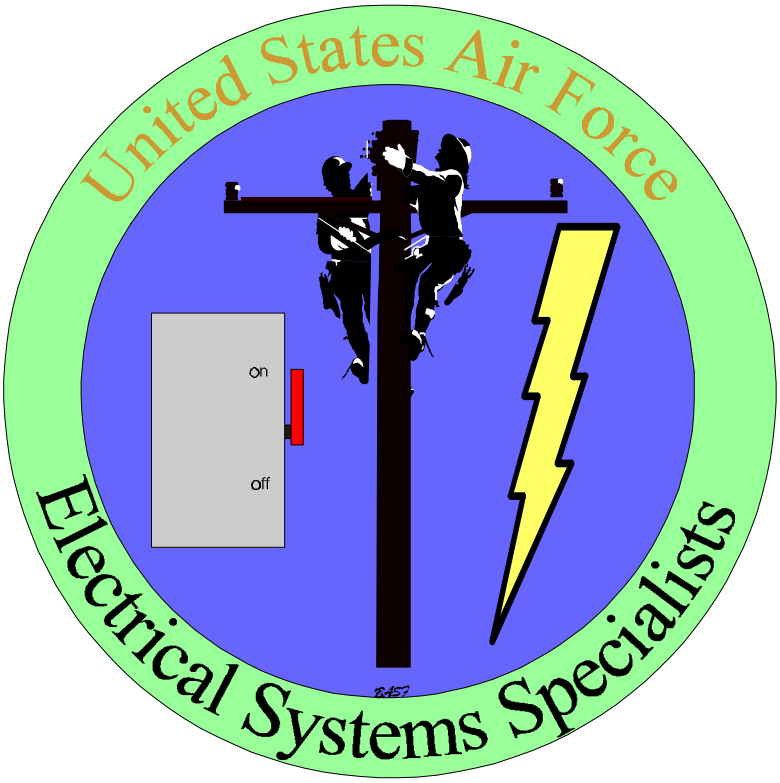
Review Questions for Climbing Equipment

Question	Answer
1. How often should body belts and safety straps be cleaned and dressed?	a. Every month b. Every two months c. Every three months d. Every six months
2. What is the suggested length of time between oiling body belts and safety straps?	a. 3 months b. 6 months c. 9 months d. 12 months
3. Which of the following IS NOT an advantage that belts made of webbing have over leather?	a. Flexibility b. Does not require special care and treatment. c. Can be judged more accurately by visual inspection. d. Three to four times as much resistance to impact loading as the same size of leather.
4. What items are checked while inspecting climbers?	a. Loose or dull gaffs b. Defective strap rings c. Excessively worn stirrups d. All of the above
5. What is the average life of a set of climbers?	a. 2 years b. 3 years c. 5 years d. 6 years
6. What two tools do you need to field sharpen gaffs that aren't machine sharpened?	a. File b. Gaff gauge c. Carborundum stone d. A and C
7. Rocking motions are avoided while sharpening gaffs to prevent rounding the edges of the gaff.	a. True b. False

CLIMBING EQUIPMENT

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee perform the following items:		
a. Clean and dress leather		
b. A visual inspection of body belt and safety strap		
c. Inspect and maintain climbers		
d. Sharpen climbers		
2. Can trainee explain proper storage techniques?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 **AFQTP UNIT 2**

USE ELECTRICIAN'S HANDTOOLS (24.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

USE ELECTRICAN'S HANDTOOLS

Task Training Guide

STS Reference Number/Title:	24.2. – Tools and equipment, use electrician's handtools
Training References:	• CDC 3E051A Vol. 4, unit 1
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• General tool box • Personal safety equipment
Learning Objective:	• Given equipment, use electrician's handtools
Samples of Behavior:	• Identify electrician's handtools • Select the correct handtool for the job • Know safety requirements to use electrician's handtools
Notes:	
• To successfully complete this element follow the steps outlined in the applicable technical manual exactly--no exceptions. • Any safety violation is an automatic failure.	

USE ELECTRICIAN'S HANDTOOLS

Background: You need to be able to identify and be familiar with some of the most commonly used handtools in order to be an efficient electrician. The screwdriver may be the most used and also most abused handtool that you will use. The abuse results when the wrong type screwdriver has been selected or it is used for a chisel or prybar. Also, when you turn a screw, never use pliers on the blade--force to the handle with your hand should work. There are two main types of screwdriver blades: the crosspoint and the standard (common) blade. Figures 1 and 2 below show different types and proper uses of screwdrivers.

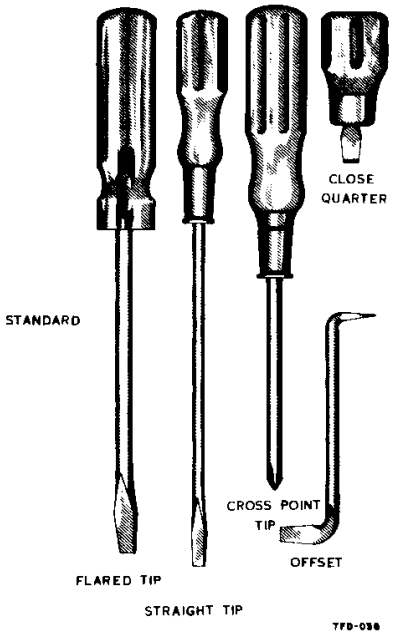


Figure 1, Screwdrivers

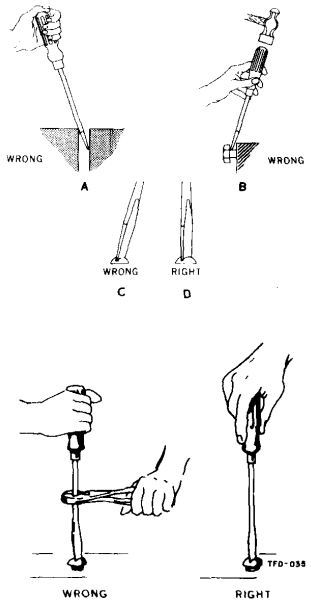


Figure 2, Use of Screwdrivers

When selecting a screwdriver, make sure the screwdriver fits the screw. If the blade is too small, you will either damage the blade or damage the slot in the head. See Figure 3 for proper selection examples. After extended use, even when used properly, it will become necessary to ground or file the screwdriver blade tip to restore it. After filing, the sides should still be parallel to keep them firmly in the screw slot. In Figure 4 the correct way to grind a screwdriver blade tip is shown. A three cornered file is used to remove nicks and burrs from a crosspoint screwdriver.

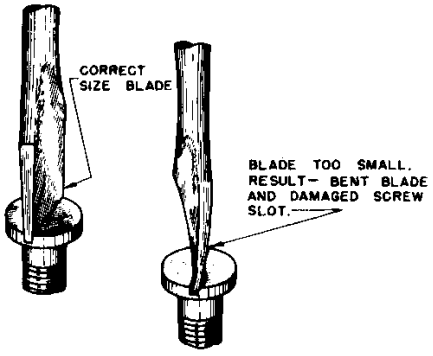


Figure 3, Blade Fit (Thickness)

Pliers are also very common handtool's for the electrician. Figure 5 shows some of the more common types including: diagonals, sidecutters (lineman's pliers), longnose (needle nose), combination slip-joint and water pump (channel-locks). Diagonals and sidecutters are used mainly for cutting wire. Diagonals work well for close cutting, while larger wire demands the use of the sidecutters. Sidecutters also work well for bending and twisting wire. Combination slip-joint and water pump pliers are adjustable to various sizes and both have long handles for extra gripping power. They are excellent tools when you're running conduit, especially when you're using raintight fittings. Longnose pliers are used for bending loops in solid wire when you need to place it under a bolthead or screwhead. Or, if your fingers aren't quite long enough, they can be used to place or tighten wires. Pliers are not intended to be an all-purpose tool. You will round the corners on nuts and bolts if pliers are used for tightening them. Never use pliers as a hammer or prybar because you may break the handles. Good judgment should be used when selecting the right set of pliers for the job. The proper size must be selected or you will be in danger of breaking the tool. The care of pliers usually calls for a drop or two of oil at the pivot point and the filing of the cutting edges with a fine file when the edge becomes pitted.

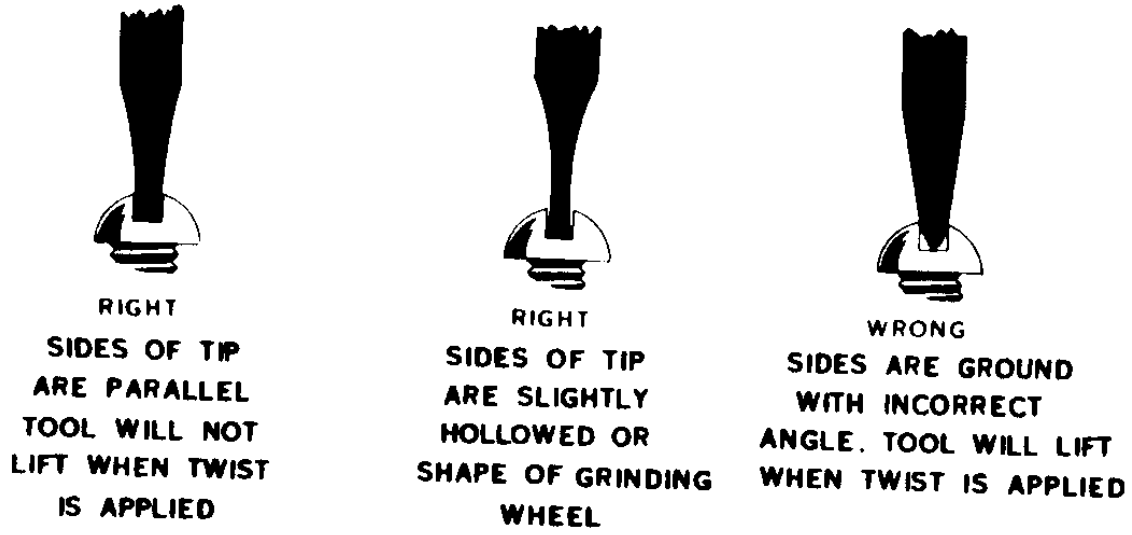


Figure 4, Blade tip shape

The hacksaw and knockout punch are two types of cutting tools used by electricians. Most hacksaws have frames that can be adjusted for different blades, which vary in length from 8 to 16 inches (See Figure 6). These blades differ by hardness and number of teeth per inch. A hard blade with 18 teeth or less is good for cutting hard metals such as rigid conduit, while a flexible blade with 24 teeth or more is good for cutting soft metals such as electrical metallic tubing (EMT). After selecting the correct blade, put it in the frame with the point of the teeth aimed away from the handle. Sawing is done by taking a light, steady, forward stroke. The weight of the saw will cause the blade to bite into the metal, no need to bear down and risk breaking the blade and possible injury. Keep the hacksaw clean and replace the blade when it becomes dull or broken.

Next is the knockout punch, it is used for enlarging holes in panels, boxes and steel cabinets and will cut metal up to 1/8 of an inch thick (See Figure 7). Stamped on the side of the punch is the diameter of the hole it will cut. For example, if you are using 2- inch conduit you will need a punch that cuts a 2 3/8-inch diameter hole. Punches range from ½ inch conduit size all the way up to 4-inch conduit size. Before you can use the tool, you must have a hole in the metal to be punched. The size of the hole is determined by the size of the punch used. The drivebolt for the ½-inch conduit punch requires a 3/8-inch hole. The drivebolt for ¾-inch conduit or larger requires a ¾-inch hole. Regardless of the size conduit being used, drill a 3/8-inch hole first. If conduit larger than ½-inch is being used, punch the hole needed for ½-inch conduit, then you will have the ¾-inch hole needed for the larger drivebolt. Insert the drivebolt through the top part (die) of the knockout and then through the hole in the box. Next you thread the bottom part (punch) onto the drivebolt ensuring the die and punch is secure against the box. Use a wrench to turn the drivebolt to punch the hole. Don't get in too big of a hurry, give the punch time to cut through the metal, the hole will have smoother edges and the punch will remain in better shape. Next, you will hear two snaps of the metal and then the slug should be free of the box. After removing the tool from the work you may need to tap the slug to free it from the die. The knockout punch will last for many years if it is kept clean and well oiled.

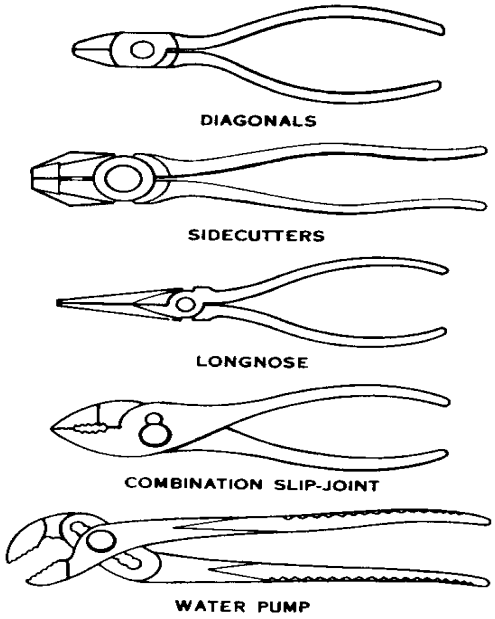


Figure 5, Pliers

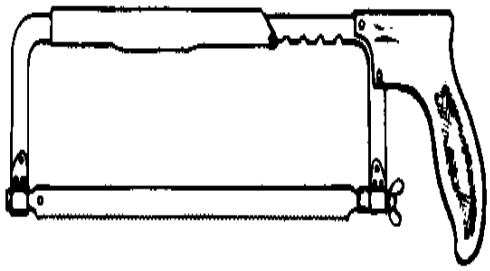


Figure 6, Hacksaw

Wrenches of various kinds are used while performing electrical work. Some for turning square materials such as nuts and bolts and some for turning round materials such as conduits. Figure 8 shows some commonly used wrenches.

Pipe Wrench. The pipe wrench uses a knurled wheel to adjust the space between the jaws. The movable jaw is spring loaded and will bind or lock when it pulls on a pipe. A pipe wrench comes in handy when you are working with rigid conduit or when large sizes of EMT are being used and the fittings are too big for channel-lock pliers.

Adjustable Open End Wrench. The adjustable open end wrench has a spiral drive wheel for jaw adjustment and the jaws should fit firmly on a nut to prevent the wrench from slipping and damaging the nut.

Open End Wrench. Open end wrenches are convenient when working space is limited because they can be turned over after each movement. The length varies with the size of the opening. If space is not a problem, the box end wrench is used because it is not as likely to slip off the nut or bolthead. It cannot be used on a square nut, only on hexagon nuts and boltheads.

Strap Wrench. The strap wrench has a thick canvas strap to grip the pipe when you don't want the finished surface to be scratched or marred.

Chain Wrench. The chain wrench is placed on the pipe by wrapping the chain around the pipe and then attaching the chain in a slot on the wrench. Two advantages of the chain wrench is that it applies pressure evenly around the entire pipe and that it is not likely to slip off the pipe.

When using a wrench of any kind, try to pull, don't push on it. The correct way to use open end wrenches is shown in Figure 9. If an adjustable jaw wrench is being used, don't apply the pulling force to the adjustable jaw. It will likely slip or break the wrench. Figure 10 shows the right and wrong way to use an adjustable end wrench. Never use a pipe (cheater) over the handle to increase leverage because this may bend or break the handle. Finally, remember the advantages and disadvantages of all the wrenches. A good electrician will not only select the best wrench for the job but also the correct wrench size, as shown in Figure 11. Keep your wrenches clean and rust free. Wipe them down occasionally with a clean cloth and light grade oil. Use a few drops of oil on the drive wheel of the adjustable jaw wrenches. When a wrench becomes battered and defective, take it out of service.

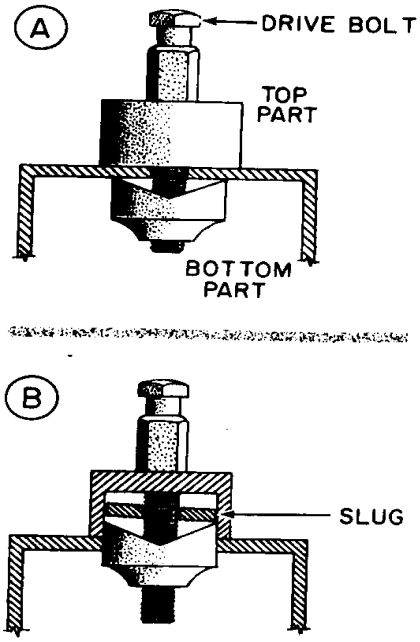


Figure 7, Knockout Punch

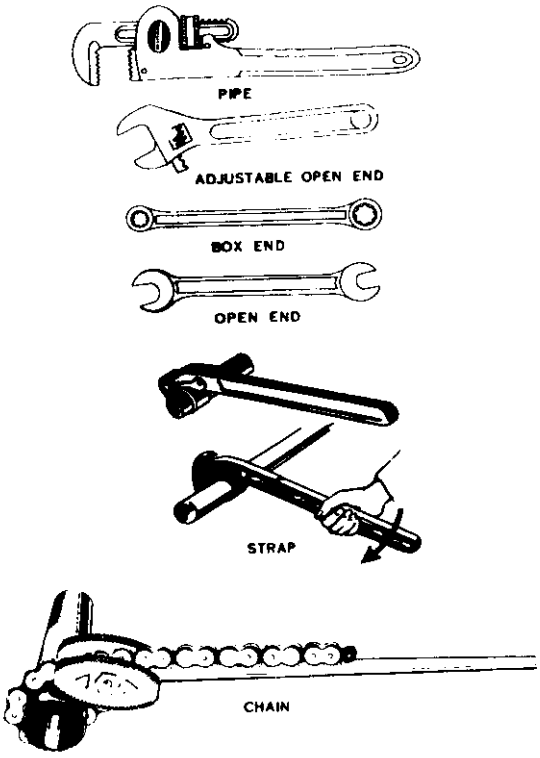


Figure 8, Wrenches

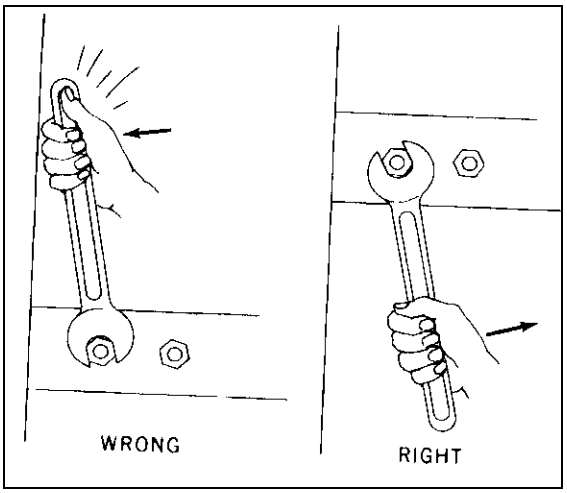


Figure 9, Proper use of Open End Wrenches

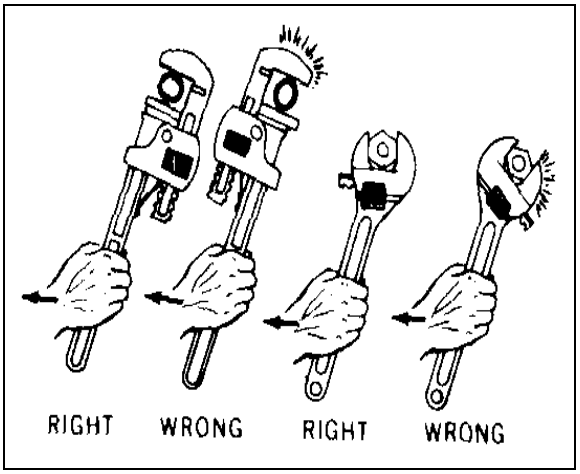


Figure 10, Proper use of Adjustable Jaw Wrenches

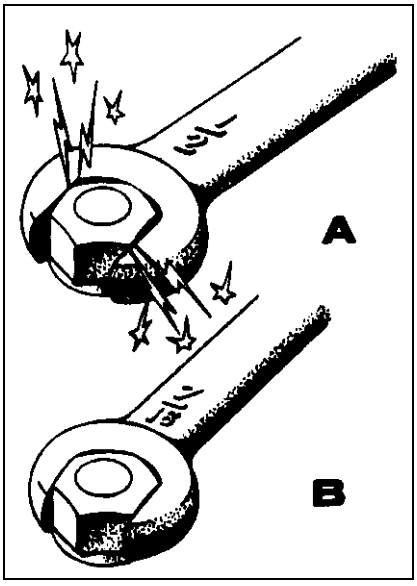


Figure 11, Selecting Correct Wrench Size

HINT:
Within normal workload constraints, set aside sufficient time to work on the package. Studies into effective training programs indicate that the best trainees reserve the same time each day to complete their study. Pace yourself, establish a schedule, and stick to it. Give yourself top priority to become qualified.

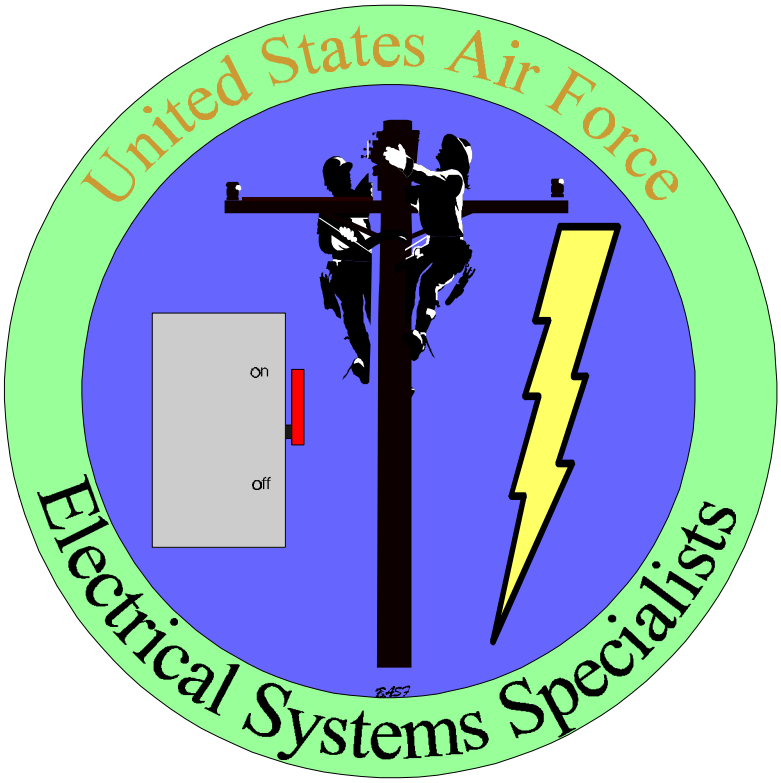
Review Questions
for
Use Electrician's Handtools

Question	Answer
1. Never use a screwdriver as a chisel or prybar.	a. True b. False
2. Which type pliers would be used to cut larger types of wire?	a. Diagonals b. Longnose c. Sidecutters d. Waterpump
3. A flexible hacksaw blade with 24 teeth or more would be best for cutting electrical metallic tubing.	a. True b. False
4. The drivebolt for the ½ inch conduit punch requires what size hole?	a. ½ inch hole b. 3/8 inch hole c. 5/8 inch hole d. ¾ inch hole
5. Which tool should you use to turn the drivebolt to punch a hole?	a. Channel-lock pliers b. Wrench c. Needle nose pliers d. Sidecutters
6. The hole you punch will have smoother edges if you give the punch time to cut.	a. True b. False
7. Which tool would you use to remove a coupling from a piece of 2 inch rigid conduit?	a. Adjustable open end wrench b. Box end wrench c. Pipe wrench d. Open end wrench
8. If space is not a problem, which tool would you use to tighten a nut onto a bolt?	a. Open end wrench b. Box end wrench c. Strap wrench d. Pipe wrench
9. A box end wrench can only be used on hexagon nuts and boltheads.	a. True b. False
10. Which one of the four statements is false.	a. Screwdrivers should always fit the screw b. Pliers can sometimes be used as hammer c. Knockout punch is used for enlarging holes d. Good electricians will select the best tool for the job
11. As a general rule, which of the following statements would be true.	a. Pliers are not intended to be an all-purpose tool b. When using a wrench of any kind try to pull the wrench toward you c. Always keep your handtool's clean and well oiled d. All of the above

USE ELECTRICIAN'S HANDTOOLS

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee identify most commonly used electrical handtools?		
2. Does the trainee know how to take care of his/her tools.		
3. Does the trainee know what to do with battered and defective tools.		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 **AFQTP UNIT 3**

USE PORTABLE POWER TOOLS (24.3.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

USE PORTABLE POWER TOOLS

Task Training Guide

STS Reference Number/Title:	24.3. – Tools and equipment, use portable power tools
Training References:	• CDC 3E051A Vol. 4
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• General Tool box • Personal safety equipment
Learning Objective:	• Given equipment, use portable power tools
Samples of Behavior:	• Follow approved methods to use an electric hand drill • Follow approved methods to use a rotary hammer • Follow approved methods to use a saber saw • Know safety requirements to use portable power tools
Notes:	
• To successfully complete this element follow the steps outlined in the applicable technical manual exactly—no exceptions. • Any safety violation is an automatic failure.	

USE PORTABLE POWER TOOLS

Background: There are many portable power tools available today, but the three most often used by electricians are the electric hand drill, the rotary hammer, and the saber saw.

The process of drilling holes in metal with an electric drill is similar to that of drilling them by hand except the turning of the drill is done by an electric motor instead of the operator. Drills come in several sizes. The drill size is determined by the largest drill bit saw that will go in the jaws of the drill. The drills usually come with either a pistol grip or Closed handle (spade grip), depending on the size of the drill. The bits are secured in the jaws of the drill by a key-type gear chuck. An example of a typical electric hand drill is shown in Figure 1.

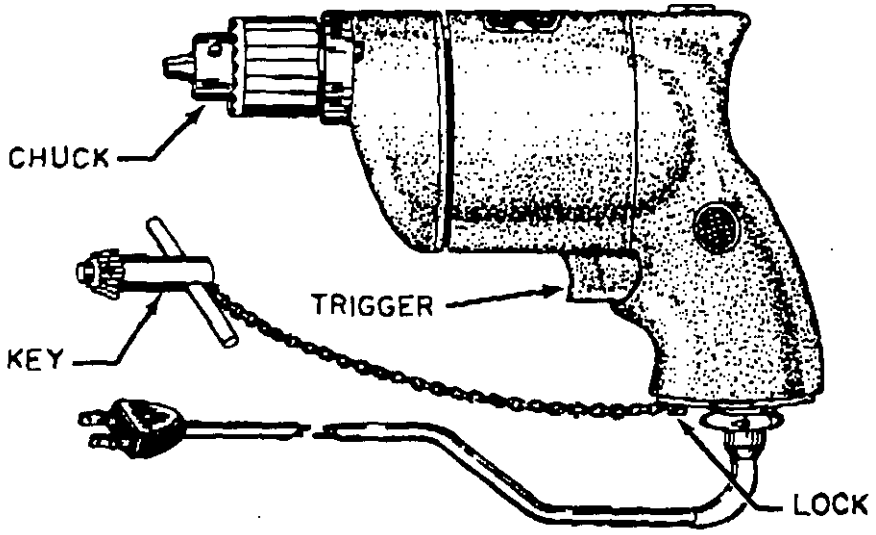


Figure 1, Portable Electric Drill

Three of the most common type bits used in the electric drill are the twist bit, spade bit, and the masonry bit, shown in Figures 2 and 3. The twist bit can be used for drilling wood or metal and is the bit that you will use most often. Center punch the spot to be drilled to prevent the bit from running. When drilling with the twist bit, reduce the pressure just before breaking through the metal and this will prevent the bit from hanging up and possibly jerking the drill out of your hands. The spade bit is used for drilling wood. Since the spade bit does not have a screw tip, pressure will have to be applied for starting and drilling. Slack off a little on the pressure when the point of the spade bit breaks through the wood to keep from splintering the material. The masonry bit is used for drilling concrete, cinder block and brick. Masonry bits come in several sizes and while they may be used in a normal electric drill for light construction work, in most cases they will be used in a rotary hammer.

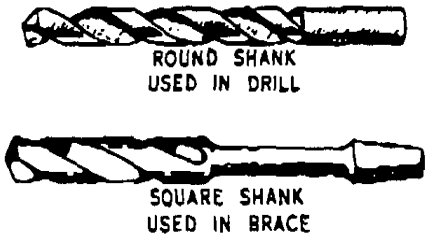


Figure 2, Twist Bits

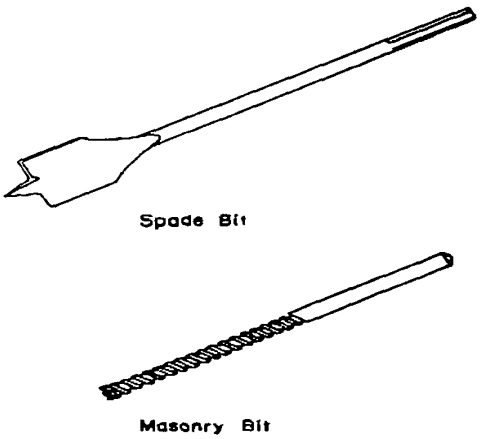


Figure 3, Spade and Masonry Bits

The rotary hammer is a portable power tool that is used most often when you have holes to drill in masonry. The rotary hammer looks just like an electric drill but it is made of heavier construction. Because it drills and hammers the bit simultaneously, even the strongest concrete can be penetrated. The rotary hammer will perform the best if only a light amount of pressure is applied to the handle.

The saber saw (shown in Figure 4) is another portable power tool that you will soon become familiar with. It is used when an opening is needed to install a box for a switch or receptacle in a finished drywall or you may need to notch a stud when running cable. Several types of blades are available depending on the material that you are cutting. To cut an opening in a finished wall. first drill a pilot hole inside the area to be cut out. Then put the blade of the saw into the hole and hold the base plate firmly against the wall before starting to cut.

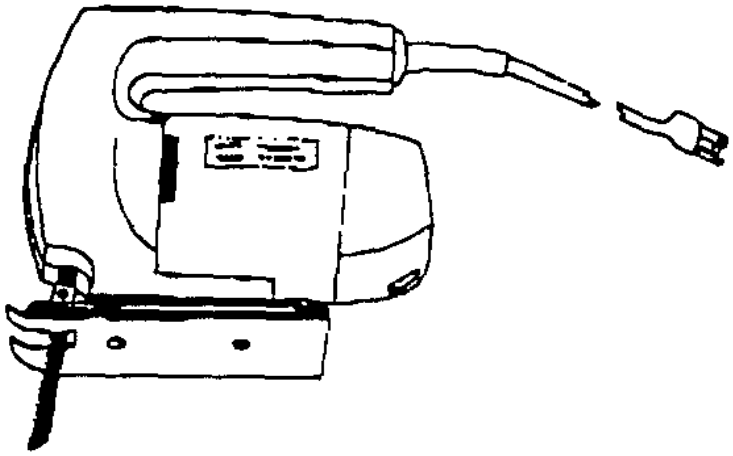


Figure 4, Saber Saw

A few things to remember when using portable power tools.

- In most cases, light even pressure is all you need for the tool to do its job. Apply too much pressure and the power tool will stall and overheat.

- Ventilation holes on power tools must be kept clean to prevent the power tool from overheating. You must also avoid putting your hands over the ventilation holes when applying pressure while drilling or cutting. The power tool must have this ventilation to operate properly.

NOTE:
Before you cut or drill into a finished wall check to make sure that you are not going to damage something that is already in the wall, there could easily be something concealed right where you want an opening.

SAFETY:
Always wear eye protection when using any portable power tool and if you will be stirring up dust when you work, wear a mask to protect your nose and throat.

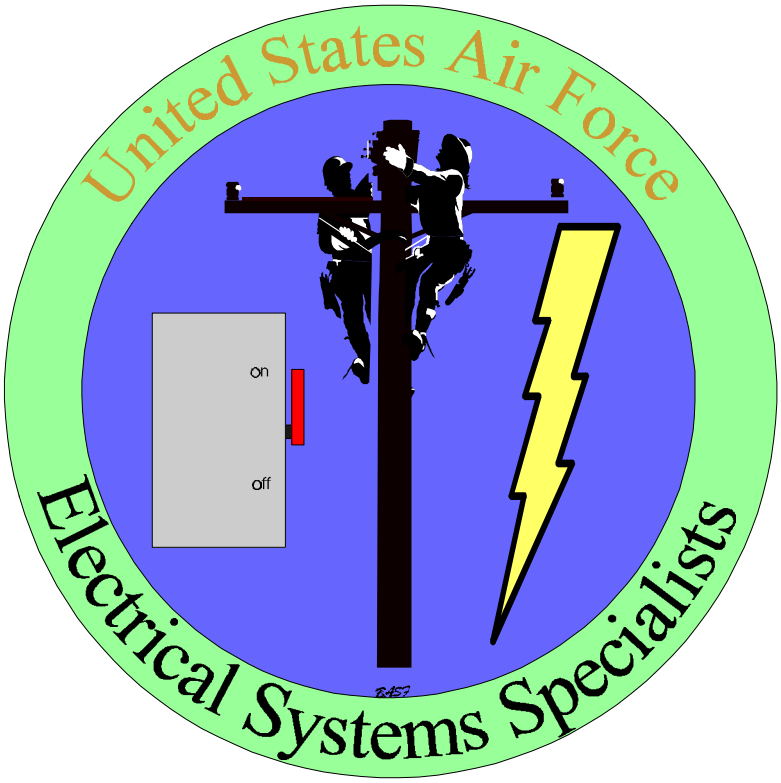
Review Questions
for
Use Portable Power Tools

Question	Answer
1. Size of the drill is determined by the largest drill bit shank that will go in the jaws of the drill.	a. True b. False
2. A spade bit is used for drilling what type material?	a. Concrete b. Wood c. Metal d. Brick
3. A masonry bit is used *for drilling* what type of material?	a. Cinder block b. Brick c. Concrete d. All of the above
4. The electric hand drill is made of heavier construction than the rotary hammer.	a. True b. False
5. The rotary hammer drills and hammers simultaneously.	a. True b. False
6. Which saw would be best for cutting an opening in a finished wall?	a. Skilsaw b. Hacksaw c. Saber saw d. None of the above
7. Ventilation holes must be kept clean to prevent power tools from overheating.	a. True b. False
8. Tight even pressure is all you need to operate most portable power tools.	a. True b. False
9. Applying to much pressure to the portable power tool will stall or overheat it.	a. True b. False
10. Always make sure there is nothing in the wall before drilling or cutting.	a. True b. False
11. When using a rotary hammer you may need to use a mask to protect your nose and throat from dust.	a. True b. False

USE PORTABLE POWER TOOLS

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee identify most commonly used portable power tools.		
2. Does the trainee know how to take care of portable power tools.		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



USE TEST EQUIPMENT

MODULE 24 **AFQTP UNIT 5**

MULTIMETER (24.5.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

MULTIMETER

Task Training Guide

STS Reference Number/Title:	24.5.1. – Tools and equipment, use test equipment, multimeter
Training References:	• CDC 3E051A Vol. 3 • AFI 32-1064 • Technical Order (T.O.) 33A12-12-651-1, For Simpson 260 Multimeter • T.O. 33A1-12-1300-1 for; Fluke Digital Multi-meter • T.O. 33A1-12-1300-1C supplement to the aforementioned T.O. • AFQTP CD-ROM 3E0X2-Power Production Test Equipment
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Multimeter
Learning Objective:	• Given equipment, use all functions on a multimeter
Samples of Behavior:	• Following approved steps, use the various functions of a multimeter • Know safety requirements for using multimeter
Notes:	
• Any safety violation will result in failure. • Trainer will demonstrate and test trainee on various applications to insure safe operations. • **TRAINER NOTE:** If more than one type of meter is available you must train on all meters that are available. If your base does not have the meter in the CD-ROM, train on the meter(s) that you have.	

MULTIMETER

Background: There are many different types of multimeters but all of them serve the same basic purpose. All analog multimeters consist of a meter coil, a means of selecting a function (A/C, D/C, Mil Amp, and so forth), a means of selecting the range or scale of measurement (0.5 to 1000), and a scale which shows the value of measurement. Remove all jewelry before attempting any measurements with the meter.

NOTE:
When using electronic meters, read the manufacturer's instructions and operating guide before attempting to use the meter. Unlike analog multimeters, electronic meters manufactured by different companies may not have the same basic principles of operation.

To perform this task, follow these steps:

Complete 3E0X2 AFQTP CD-ROM "Power Production Test Equipment".

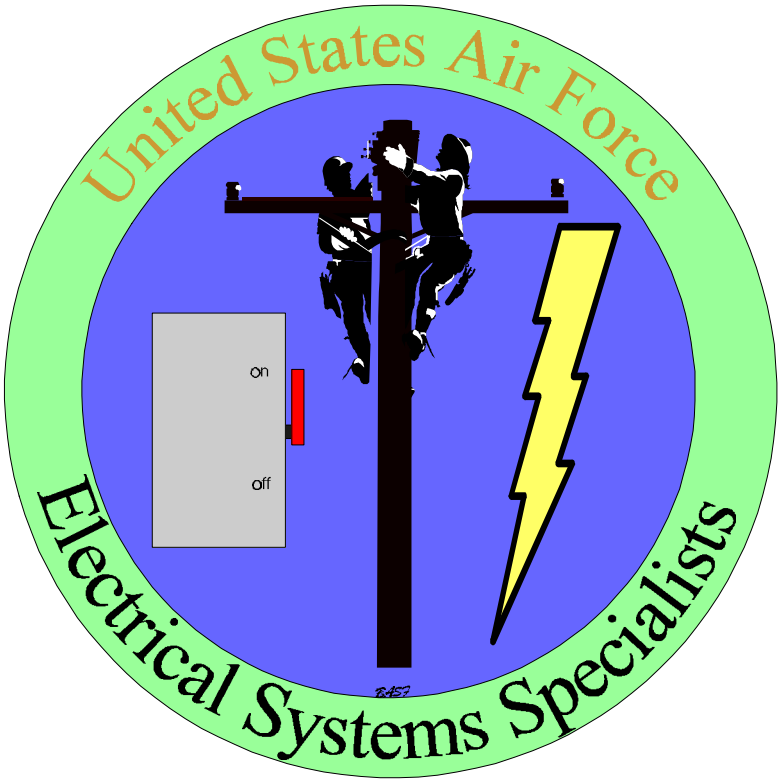
Review Questions for Multimeter

Complete the review questions for the multimeter contained in the AFQTP CD-ROM 3E0X2, “Power Production Test Equipment.

MULTIMETER

Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee select correct setting on function switch?		
2. Can the trainee correctly "Zero" the meter?		
3. Did the trainee select proper range scale for voltmeter?		
4. Did the trainee know the purpose of the function switch?		
5. Did the trainee operate the ammeter correctly?		
6. Did the trainee turn off power prior to checking resistance?		
7. Did the trainee turn off power prior to checking amps?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



USE TEST EQUIPMENT

MODULE 24 **AFQTP UNIT 5**

CLAMP-ON AMMETER (24.5.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

CLAMP-ON AMMETER

Task Training Guide

STS Reference Number/Title:	24.5.2. – Tools and equipment, use test equipment, clamp-on ammeter
Training References:	• CDC 3E051A Vol. 3 • AFI 32-1064 • Electrical safe practices • AFQTP CD-ROM 3E0X2 "Power Production Test Equipment"
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Clamp-on Ammeter
Learning Objective:	• Given equipment, use of all functions on an ammeter
Samples of Behavior:	• Following approved steps, use the various functions of an ammeter • Know safety requirements for using an ammeter
Notes:	
• Any safety violation is an automatic failure.	

CLAMP-ON AMMETER

Background: There are times when you must measure the current flow in an AC circuit to ensure proper circuit function and to prevent damage to equipment. There are several meters available to measure current flow but the simplest and easiest meter to use is the clamp-on ammeter. Most clamp-on ammeters are multimeters. That is, they measure either voltage or amperage.

SAFETY:

- **WHEN TAKING MEASUREMENTS DO NOT TOUCH THE JAWS OF THE METER. HOLD THE METER BY THE HAND-GRIP ONLY.**
- **IF AMPROBE IS TO BE USED ON HIGH-VOLTAGE USE RUBBER GLOVES. IF USED ON THE PRIMARY SIDE OF A TRANSFORMER, UTILIZE THE NEUTRAL SIDE OF THE PRIMARY AS THE SPOT TO TAKE THE READING FROM. CHECKING THE NEUTRAL SIDE CONNECTION OF THE TRANSFORMER WILL YIELD THE SAME READING AS THE HOT SIDE**

NOTE:
If you want to measure the total amperage of a multi-tap connector with several conductors of one phase of power, you must take a reading of all conductors individually and add each together to find the total of that phase.

To perform this task, follow these steps:

Complete 3E0X2 AFQTP CD-ROM “Power Production Test Equipment”.

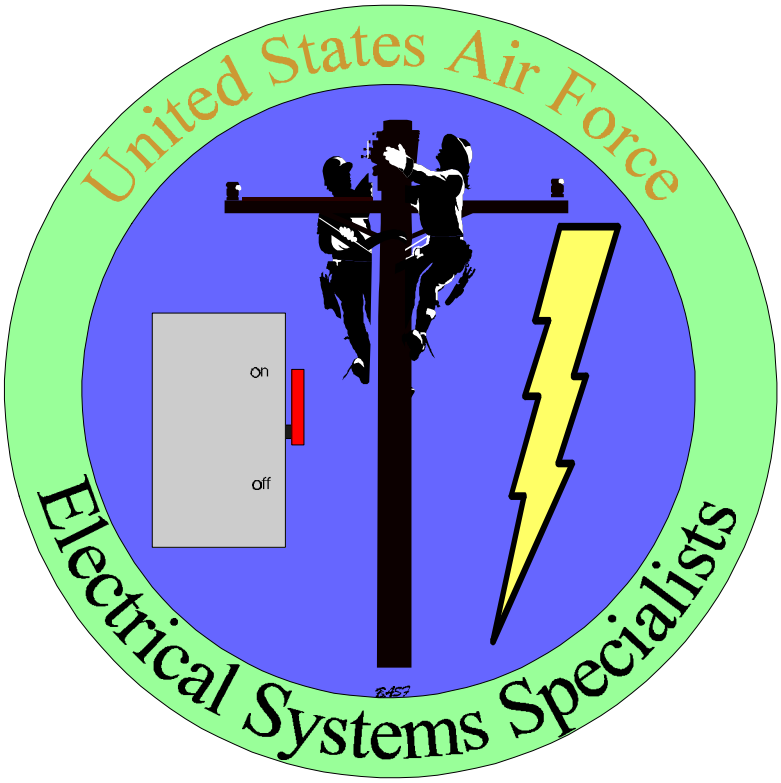
Review Questions
for
Clamp-on Ammeter

Complete the review questions for the multimeter contained in the AFQTP CD-ROM 3E0X2, “Power Production Test Equipment.

CLAMP-ON AMMETER

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee place the switch in the desired amperage range?		
2. Does trainee know how to properly take readings for several conductors?		
3. Does trainee know when to set to the highest setting?		
4. Can trainee state all safety precautions?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



USE TEST EQUIPMENT

MODULE 24 **AFQTP UNIT 5**

PHASE ROTATION METER (24.5.3.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

PHASE ROTATION METER

Task Training Guide

STS Reference Number/Title:	24.5.3. – Tools and equipment, use test equipment, phase rotation meter
Training References:	• CDC 3E051A Vol. 3 • AFI 32-1064, Electrical Safe Practices • AFQTP CD-ROM 3E0X2 "Power Production Test Equipment"
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Phase Rotation Meter • 3 Phase power source • Voltmeter
Learning Objective:	• Given equipment, use a phase rotation meter
Samples of Behavior:	• Following approved steps, use the various functions of a phase rotation meter • Know safety requirements for using a phase rotation meter
Notes:	
• Any safety violation is an automatic failure.	

PHASE ROTATION METER

Background: The purpose of a phase-rotation meter is to determine the phase sequence of a three-phase circuit. Most industrial facilities use equipment that is run by three phase motors. In order to connect a three phase motor and have it turn in the proper direction, you need to know which wire of the power supply is A phase, B phase, and C phase. It is often necessary to know the phase sequence for the following reasons: to make sure motors rotate in the proper direction; to properly connect three phase transformer banks, generators, and busses; to ensure the proper phase sequence when replacing a three-phase transformer bank; to connect meters, instruments, and other components in the right rotation. There are two basic types of phase rotation meters. The first type is the (neon) glow lamp type. The face of the meter has two neon lamps which glow at an uneven brightness for a given phase. The lamp that is glowing the brightest indicates the phase rotation of the system. This meter has selector switches for different voltages. Ensure the selector switch is set at the proper voltage before making any connections. The second type of meter is the motor driven type. When this meter is connected to the system a rotation disk in the center of the case indicates the sequence of rotation. This meter has no selection switch and it operates in the 60 to 600 volt range.

SAFETY:
EXERCISE EXTREME CAUTION WHEN CONNECTING THE PHASE ROTATION METER TO LIVE CIRCUITS! WEAR SAFETY EQUIPMENT AND REMOVE ALL JEWELRY

To perform this task, follow these steps:

Complete 3E0X2 AFQTP CD-ROM “Power Production Test Equipment”.

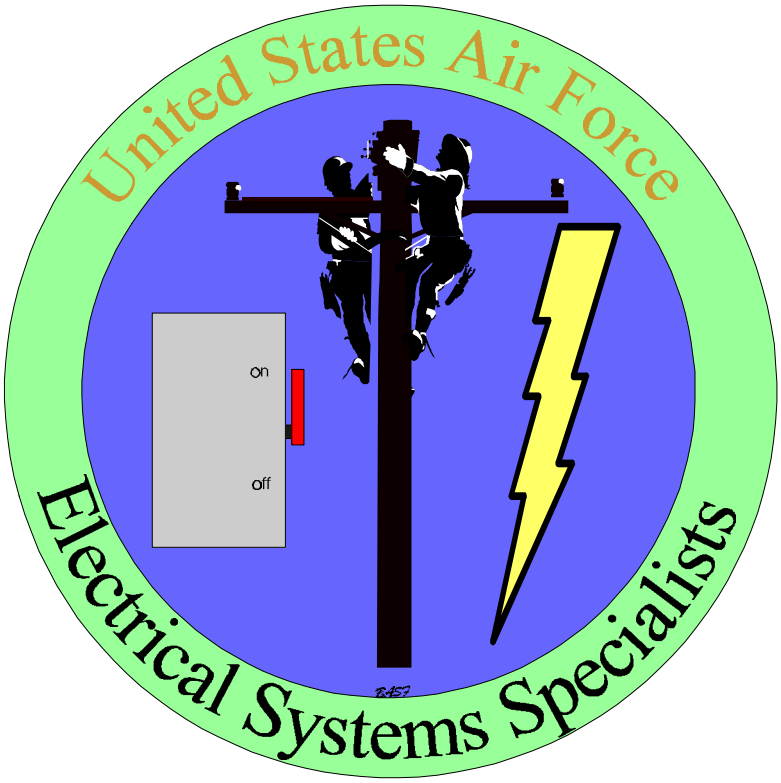
Review Questions
for
Phase Rotation Meter

Complete the review questions for the multimeter contained in the AFQTP CD-ROM 3E0X2, “Power Production Test Equipment.

PHASE ROTATION METER

Performance Checklist		
Step	**Yes**	**No**
1. Does trainee understand purpose of phase rotation meter?		
2. Does trainee understand proper phase rotation sequence?		
3. Does trainee know the difference between the motor-driven and the (neon) glow-lamp type rotation meter?		
4. Can trainee properly interpret phase meter readings?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



USE TEST EQUIPMENT

MODULE 24 **AFQTP UNIT 5**

MEGOHMMETER (24.5.4.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

MEGOHMMETER

Task Training Guide

STS Reference Number/Title:	24.5.4. – Tools and equipment, use test equipment, megohmmeter
Training References:	• CDC 3E051A Vol. 3, MEG-CHEK MANUAL 17456 • T.O. 33A1-4-5-11 for the PSM1/A and PSM2/A hand-crank • AFQTP CD-ROM 3E0X2 "Power Production Test Equipment"
Prerequisites:	• Possess a minimum of a 3E031 AFSC
Equipment/Tools Required:	• Megohmmeter • Two conductors of a de-energized circuit
Learning Objective:	• Provided proper equipment, use the megohmmeter. • .
Samples of Behavior:	• Following proper procedures, use the various functions of a Megohmmeter. • Know safety requirements involved while using a megohmmeter.
Notes:	
• Any safety violation is an automatic failure. • Trainer; Your equipment may vary. Use this as a teaching guide to insure trainee can successfully operate a Megohmmeter. If hand crank and digital are available train on both.	

MEGOHMMETER

Background: The megohmmeter, also known as a "megger", is used to determine the resistance value between two isolated conductors, such as a neutral conductor and a phase. It can be used to determine that each motor, generator, or transformer winding is separate and not shorted together, or making contact to ground. It can also be used to indicate that a winding has continuity, such as in the case with the primary winding of a single phase transformer.

The meter will produce one of three results. They are: a true ohmic value (represented in megohms), Infinity, or zero. A reading of zero (or near zero) will indicate that there is continuity between 2 test points such as when testing a single conductor from end to end. Infinity indicates that the two test points are NOT connected, as with the secondary and primary windings in a transformer. The true ohmic value may be useful when testing the insulation of a conductor. For instance, when testing an underground cable with a megger, a low megohm value between the neutral or ground, and the phase may be an indication that the insulation is breaking down.

There are two types of Megohmmeters that are used today. They are the manual hand-crank model and the Electronic Insulation Tester.

SAFETY:

- **NEVER USE A MEGOHMMETER ON A LIVE CIRCUIT.**
- **NEVER USE A MEGOHMMETER IN AN EXPLOSIVE ENVIRONMENT OR IN AN AREA WHERE CONDUCTORSPASS THROUGH AN EXPLOSION PROOF AREA. (THE MEGOHMMETER IS A HIGH-VOLTAGE AND SPARK PRODUCING APPARATUS.)**
- **USE EXTREME CAUTION WHILE TESTING CONDUCTORS TO INSURE THAT EVERYONE IS CLEAR OF THE CIRCUIT**

To perform this task, follow these steps:

Complete 3E0X2 AFQTP CD-ROM “Power Production Test Equipment”.

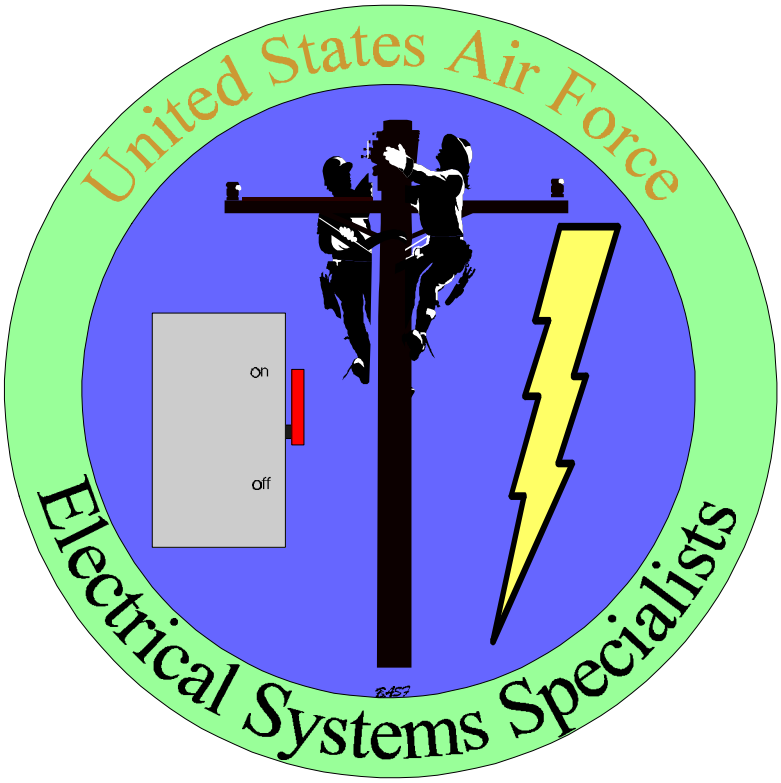
Review Questions
for
Megohmmeter

Complete the review questions for the multimeter contained in the AFQTP CD-ROM 3E0X2, “Power Production Test Equipment.

MEGOHMMETER

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee explain the uses of a Megohmmeter?		
2. Does trainee know the different types of Megohmmeter?		
3. Does trainee know the general safety procedures associated with use of the Megohmmeter?		
4. Does trainee know the Steps involved in taking an accurate meter reading?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



USE TEST EQUIPMENT

MODULE 24 **AFQTP UNIT 5**

HIGH VOLTAGE PHASE TESTER (24.5.14.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

HIGH VOLTAGE PHASE TESTER

Task Training Guide

STS Reference Number/Title:	24.5.14. – Tools and equipment, use test equipment, high voltage phase tester
Training References:	• CDC 3E051A vol. 3 • AFR 32-1064, Electrical Safe Practices • T.O.33A1-12-963-1 30 JAN. 1978 • Chance Phasing Tool Manual
Prerequisites:	• Possess as a minimum of a 3E031 AFSC
Equipment/Tools Required:	• Personal protective equipment • Extension sticks • High Voltage Phase tester
Learning Objective:	• Given equipment, use the high voltage phase tester
Samples of Behavior:	• Following approved steps, use the various functions of a high voltage phase tester • Know safety requirements for using a high voltage phase tester
Notes:	
• Any safety violation is an automatic failure.	

HIGH VOLTAGE PHASE TESTER

Background: The High Voltage Phase Tester is a portable device that permits the checking of AC voltages on distribution and transmission circuits. It allows measurements from 0V to 75 kV and determines phase relationships and the approximate line-to-line or line-to-ground voltage. The basic instrument is designed so voltages up to 16 kV can be read directly on the black scale of the meter. This unit consists of two high-impedance units housed in the contact ends of the two epoxyglas housings. The resistance units are enclosed in a suitable compound epoxy to protect them from mechanical damage and to prevent moisture penetration or accumulation around the resisters. For use on lines above 16 kV, two resistor sticks are provided, increasing the voltage range to 48 kV. With these extensions in place, the reading is then multiplied by 3. To measure voltages of up to 80 kV, add a second pair of resister sticks and multiply by 5.

SAFETY:
KEEP RESISTOR PORTION OF TOOL CLEAN AND DRY. KEEP INSULATION IN GOOD WORKING CONDITION. IF IT BECOMES FRAYED, DISCONTINUE USE AND INFORM SUPERVISOR IMMEDIATELY. MAINTAIN WORKING CLEARANCE BETWEEN HANDS, METER, AND CABLE BY USING PROPER LENGTH UNIVERSAL POLES.

Overhead distribution systems.

To perform this task, follow these steps:

Step 1: Be knowledgeable of system voltage.

Step 2: Choose proper stick configuration for system voltage to be tested.

Step 3: Test each line to ground.

NOTE:
When testing line to ground voltage, the handle on which the meter is mounted is placed at the ground potential contact, to minimize stray capacitance influence on the meter.

Step 4: Test line-to-line voltage.

NOTE:
For line-to-line measurements contact is made to each phase conductor keeping the connecting cable as far as possible from other conductors, grounded or metal structures, and away from platforms or earth contact. This helps avoid influences that may distort meter indications.

Underground Systems.

To perform these tasks, follow these steps:

Step 1: Be knowledgeable of system voltage, if unknown check with Electrical Systems supervisor.

Step 2: Choose proper stick configuration for system voltage to be tested.

Step 3: Test each line to ground.

NOTE:

- When testing line to ground voltage, the handle on which the meter is mounted is placed at the ground potential contact, to minimize stray capacitance influence on the meter.
- To test underground rural distribution equipment a small hex head screw (1/4 by 20, 3/8 inch long) could be inserted to protect the female thread.

SAFETY:

DO NOT USE ANY PROBES ON THE PHASING TESTER WHEN TESTING LIVE-FRONT UNDERGROUND RURAL DISTRIBUTION EQUIPMENT, DUE TO THE CLOSE PROXIMITY OF ENERGIZED PARTS AND GROUNDED SURFACES. THIS COULD CAUSE FLASH OVER. USE PROPER ELBOW OR BUSHING ADAPTERS WHEN TESTING DEAD-FRONT UNDERGROUND RURAL DISTRIBUTION EQUIPMENT.

Step 4: Test line-to-line voltages.

NOTE:

In tying two energized three-phase feeders together where it is necessary to match phases, voltage measurements must be made between a conductor of one circuit and each of the conductors of the second circuit. This procedure is followed for each phase to avoid connecting phases in reversed order.

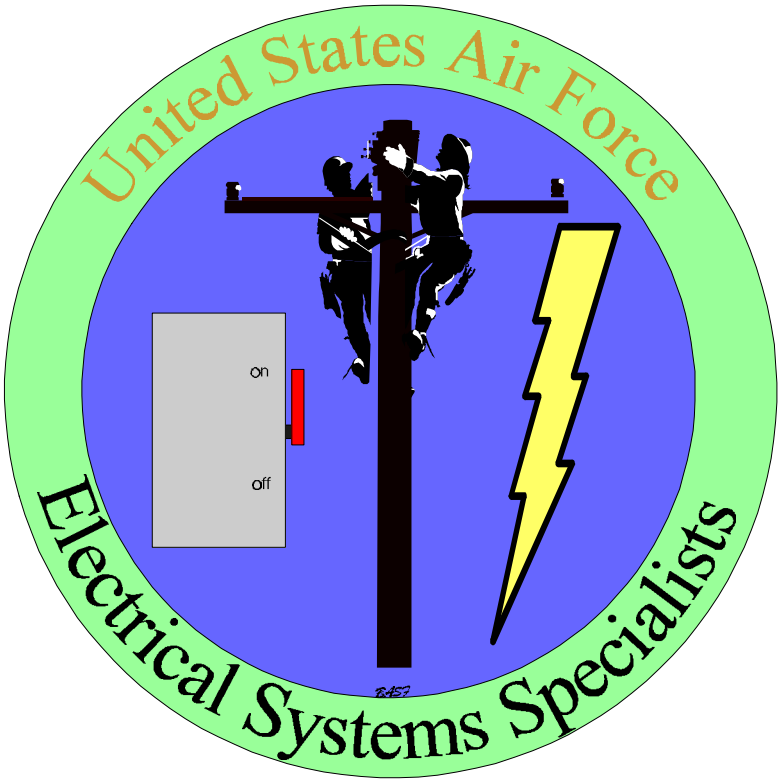
Review Questions
for
High Voltage Phase Tester

Question	Answer
1. The basic instrument can test voltages up to?	a. 20,000 volts b. 14,000 volts c. 10,000 volts d. 16,000 volts
2. When using a second pair of resistor sticks you multiply the meter reading by _____?	a. 3 b. 5 c. 7 d. 10
3. Why is the handle on which the meter is mounted placed on the ground potential contact?	a. To reduce stray capacitance that may influence reading b. Enables the user to read the scale more with ease c. Reduces the length cable necessary to make the reading d. Insures proper polarity in the A/C circuit
4. Why must you not use probes on live front underground rural distribution equipment?	a. Accurate reading cannot be obtained b. The cables are not long enough. c. Phasing sticks are only to be used while in the bucket truck d. Working in close proximity of energized parts and grounded surfaces
5. What should you do if you notice frayed insulation on the test cable?	a. Make temporary fix with tape b. Use an additional resistor c. Disregard and use it d. Do not use and immediately inform supervisor

HIGH VOLTAGE PHASE TESTER

Performance Checklist		
Step	**Yes**	**No**
1. Is trainee knowledgeable of system voltage prior to using meter?		
2. Does trainee know proper meter configurations?		
3. Does trainee know the proper procedure for testing live-front underground distribution equipment?		
4. Is trainee aware of safety precautions associated with the use of high voltage phase tester?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



USE TEST EQUIPMENT

MODULE 24 **AFQTP UNIT 5**

EARTH RESISTANCE TESTER (24.5.16.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

EARTH RESISTANCE TESTER

Task Training Guide

STS Reference Number/Title:	24.5.16. – Tools and equipment, use test equipment, earth resistance tester
Training References:	• CDC 3E051A Vol. 3 • AFR 32-1064, Electrical Safe Practices • Vibroground manual #18507 • T.O. 33A1-12-687-1 for model 263 and 293
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Vibroground, Rubber gloves,
Learning Objective:	• Given equipment, obtain ground resistance readings using the Earth Resistance Meter (Vibroground) and the 3 point method
Samples of Behavior:	• Following approved steps, use the various functions of an earth resistance meter • Know safety requirements for using an earth resistance meter
Notes:	
• Any safety violation is an automatic failure.	

EARTH RESISTANCE TESTER

Background: The Vibroground is a test instrument that gathers ground resistance readings from installed grounds. This device uses a null balance metering system. It provides a reading directly in ohms, minimizing the need for calculations.

3 Point Method.

To perform this task, follow these steps:

Step 1: Establish location for test electrodes.

NOTE:
Typical spacing between X and 2 is 80 to 90 feet, and between X and 1 is 50 to 55 feet. Follow manufacturer's instructions for details.

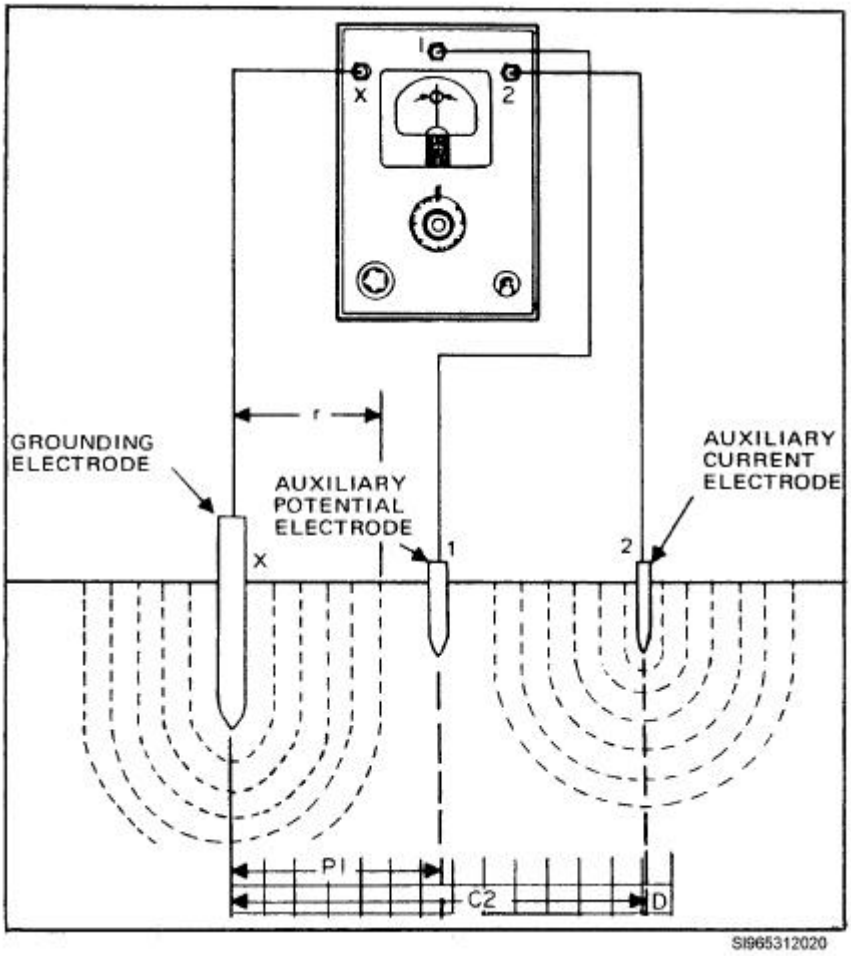


Figure 1, Basic setup for measuring earth resistance

Step 2: Connect ground electrode and test electrodes.

- **Connect ground being tested to meter.**
- **Connect potential electrode to P1 on meter.**
- **Connect current electrode to C1 on meter.**

Step 3: Set range switch to its highest position.

Step 4: Move the test switch to the ADJ position.

NOTE:
Rotate the OHMS control knob until the galvanometer indicates balance. Move the TEST switch to the READ position and rebalance the galvanometer.

Step 5: Read the resistance on the calibrated Ohms scale.

NOTE:
If this indication is less than 1/10 of full range, set the RANGE switch to the next lower range and repeat step four.

Step 6: Multiply the Ohms scale indication by the factor indicated by the RANGE switch.

NOTE:
- This product is the actual resistance of the grounding system under test. If you are unable to balance the galvanometer on any range, improper connections may be responsible, or the grounding system resistance may be beyond the range of the instrument.
- For further guidance on the use of the Vibroground consult AFI 32-1065, Attachment 6.

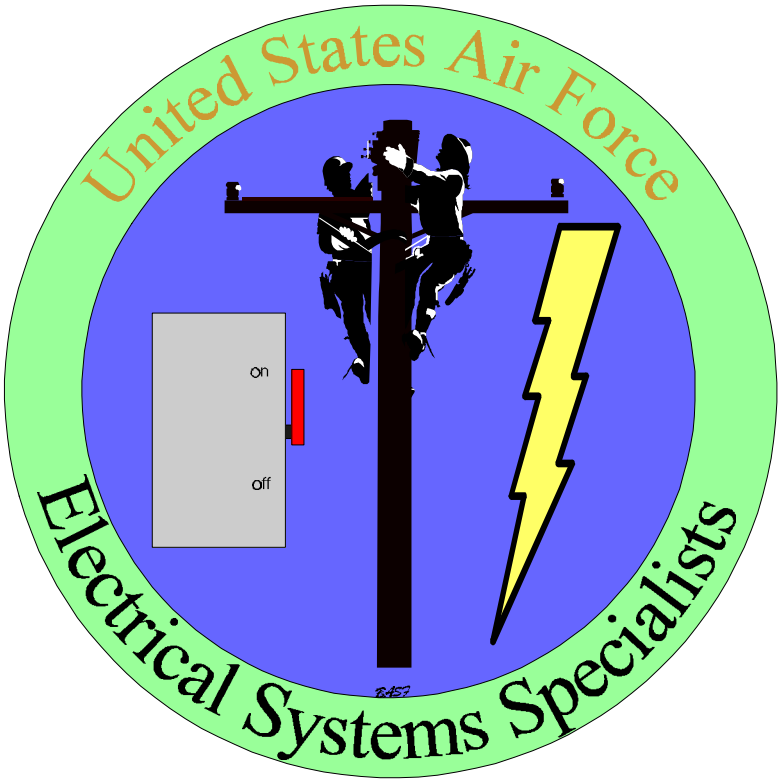
Review Questions
for
Earth Resistance Tester

Question	Answer
1. The purpose of the Vibroground is to gather ground resistance readings from installed grounds.	a. True b. False
2. Unlike the separate voltmeter, ammeter method, this instrument provides a readout directly in volts.	a. True b. False
3. If you are unable to balance galvanometer on any range, what is the most likely cause(s)?	a. a. High humidity b. Improper connections c. Resistance beyond range of meter d. Both b & c
4. Which electrode is connected to C1 on the Vibroground.	a. a. Potential b. Current c. Ground

EARTH RESISTANCE TESTER

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee establish proper location for test electrodes?		
2. Did trainee properly connect test and ground electrodes?		
3. Did trainee properly read the resistance on the calibrated ohms scale?		
4. Does trainee know the proper personal protective equipment to use when operating the Vibroground?		

FEEDBACK: Trainer should provide immediate positive and/or negative feedback to the trainee after the task is performedto ensure that the issue is still fresh in the minds of both the trainee and the trainer.



TOOLS AND EQUIPMENT

MODULE 24 **AFQTP UNIT 6**

PERFORM OPERATOR'S MAINTENANCE ON HIGH REACH TRUCK WITH INSULATED BUCKET (24.6.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

PERFORM OPERATOR'S MAINTENANCE ON HIGH REACH TRUCK WITH INSULATED BUCKET

Task Training Guide

STS Reference Number/Title:	24.6. – Tools and equipment, perform operator's maintenance on high reach truck with insulated bucket
Training References:	• CDC 3E051B Vol. 1 • AFI 32-1064, Electrical Safe Practices • T.O. 36A12-5-1-181 and 182 • AFI 24-301, Vehicle Operations
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• High Reach Truck, Leather Gloves, Hard Hat, AF Form 1806
Learning Objective:	• Given equipment, perform operator's maintenance on high reach truck with insulated bucket
Samples of Behavior:	• Following approved steps, perform the operator's maintenance on a high reach truck with insulated bucket • Know safety requirements for performing operator's maintenance on a high reach truck with bucket
Notes:	
• Any safety violation is an automatic failure.	

PERFORM OPERATOR'S MAINTENANCE ON HIGH REACH TRUCK WITH INSULATED BUCKET

Background: Special-purpose vehicles for power line work have greatly reduced the physical labor that once was required in this work. One person operating the power supplied by the truck has the physical strength of several people working with hand tools. As with almost everything else however, accidents can happen. In the process of investigating bucket truck accidents over a period of years, it became clear that operator error and/or lack of proper maintenance were primary reasons for these accidents. We'll talk about these areas of operator safety and operating instructions in this unit.

The Air Force has invested a great deal of money in maintenance trucks. Ensuring that the equipment has the proper care protects this investment, which makes your job easier. Let's look at a few of the pre-operation inspection items you should check before operating the maintenance truck.

To perform these tasks, follow these steps:

Step 1: Pre-operational check.

- Check them daily and note any discrepancies in AF Form 1806, Operator's Inspection Guide and Trouble Report (Aircraft Towing, Base Maintenance, Deicers, High Reach and Snow Removal).
- The operator maintains things such as cleanliness, tire pressure, battery water, fuel, oil, and coolant levels.
- For all other discrepancies, turn the truck into the motor pool for repair as soon as possible. Now check the actual AF Form 1806 in Figures 1 and 2 as we clarify particular inspection items on the form.
- Check for damage, such as damaged or missing external or internal components.
- Check for oil, fuel, and hydraulic leaks.
- Keep the tire pressure at the level that is consistent with the tire's manufacturer and found on the side-wall of the tire.
- The operator keeps proper levels of fuel, oil, and coolant.
- Check the battery terminals for tightness and cleanliness, and check the water level in each cell.
- Check the horn for proper operation.
- Make sure all lights work and that the reflectors aren't broken.
- Check the instruments and see that the windshield wipers work properly and the blades are in good condition.
- If there are windshield washers, be sure the reservoir is full and they operate properly.
- Clean the windshield—especially if it's covered with hydraulic fluid or tree sap from tree trimming. Cargo and mounted equipment checks include booms, buckets, front jacks, rear jacks, and the controls.
- Clean the vehicle inside and out—at least once a week or as needed for proper cleanliness.
- The truck must also be waxed periodically.
- Check the steering for looseness, wandering, or shimmying.

- Check the power steering fluid, if there is any.
- Make sure all safety devices are intact and operating properly.
- Check the fan, generator, power steering, hydraulic pump, and air compressor drive belts and pulleys and the cable pulleys on the booms.
- Check the brakes for pulling, grabbing, or softness.
- The motor pool should change the oil and lubricate the truck periodically.

Step 2: Operational check.

- The operational inspection is made while the vehicle or auxiliary equipment is in use.
- Check for noises; such as metal screeching against metal, loose belts, or engine noises.

NOTE:
Things like this can only be identified while the vehicle or equipment is in use.

- Checking for leaks is easy because of the pressure generated by the pumps.
- During operation, inspect all hydraulic connections for visible leaks.
- Also check oil levels of the hydraulic system during operation, and check the hydraulic reservoir site glass periodically.
- If the oil drops below the site glass, stop operation and fill the system tank.
- Absence of fluid in the tank will cause strain and damage to truck equipment.
- Continually check the gauges to ensure correct hydraulic pressure to protect the equipment.
- Make sure there's enough fuel to complete the job.

NOTE:
The most important gauge to watch is the tachometer. Don't exceed the manufacturer's specifications for maximum engine revolutions per minute (rpm).

Step 3: Post-operational checks.

- Make the post-op check every time you've finished with the vehicle for the day, and before storing the truck.
- This lets you identify any damage, minor or major, that may have been overlooked during the day's work.
- Note any discrepancies during the pre-op, operational, or post-op checks and annotate your findings on AF Form 1806.
- Notify your supervisor and then turn the truck into the motor pool for repair.

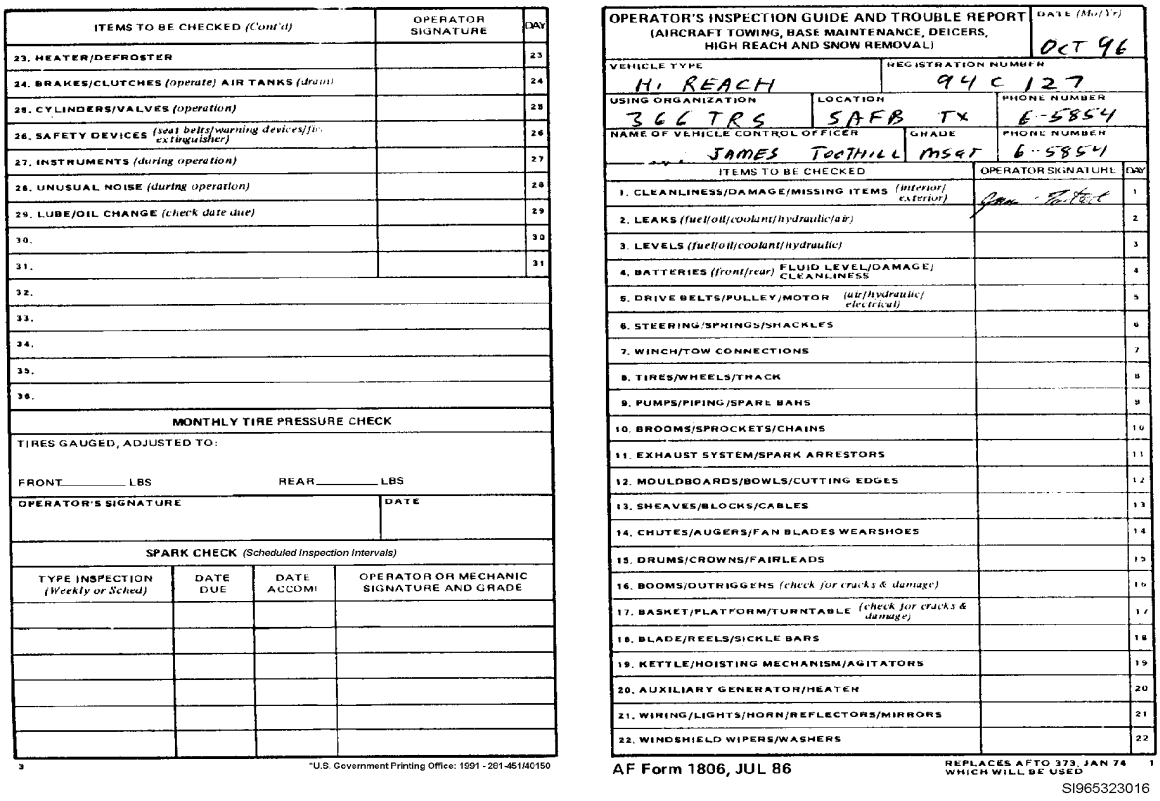
Step 4: Vehicle maintenance.

- Necessary periodic maintenance schedules are in the manufacturer's maintenance and operation manual for each unit. Use only standard parts furnished by the manufacturer.
- Keep all fiberglass coated or wrapped, and keep booms and buckets clean by hand washing with a mild detergent and hand rinsing.
- Don't use a high-pressure water hose.
- Make electrical tests on insulation every 6 months, or more frequently when the need is indicated, according to TO 36C–1–4.

- When the weather is below freezing, operate the hydraulic pump 5 to 10 minutes before operating the boom.
- Refer to the operation manual for the grade and maintenance of hydraulic fluid that lets you put the unit in operation with minimum warm-up time.
- Line purging or any repair that involves opening the hydraulic pressure system pressure lines must be done by a qualified person.
- Check maximum allowable load operation through all positions periodically.
- Check boom and leveling wire rope cables for frayed strands, security of terminals, and correct adjustment.

Step 5: Rental units.

- Notify the BCE if the insulated personnel lifting device becomes inoperable and the estimated return-to-service date is more than 10 days.
- Upon notification, the BCE should forward a request to the Transportation Squadron Fleet Manager for rental/lease vehicle support.
- Rental vehicles must be thoroughly inspected and tested before initial use.



ITEMS TO BE CHECKED (Cont'd)	OPERATOR SIGNATURE	DAY
23. HEATER/DEFROSTER		23
24. BRAKES/CLUTCHES (operate) AIR TANKS (drain)		24
25. CYLINDERS/VALVES (operation)		25
26. SAFETY DEVICES (seat belts/warning devices/fire extinguisher)		26
27. INSTRUMENTS (during operation)		27
28. UNUSUAL NOISE (during operation)		28
29. LUBE/OIL CHANGE (check date due)		29
30.		30
31.		31
32.		
33.		
34.		
35.		
36.		

MONTHLY TIRE PRESSURE CHECK

TIRES GAUGED, ADJUSTED TO:

FRONT_____LBS REAR_____LBS

OPERATOR'S SIGNATURE	DATE

SPARK CHECK (Scheduled Inspection Intervals)

TYPE INSPECTION (Weekly or Sched)	DATE DUE	DATE ACCOMP	OPERATOR OR MECHANIC SIGNATURE AND GRADE

3 *U.S. Government Printing Office: 1991 - 261-451/40150

OPERATOR'S INSPECTION GUIDE AND TROUBLE REPORT (AIRCRAFT TOWING, BASE MAINTENANCE, DEICERS, HIGH REACH AND SNOW REMOVAL) — DATE (Mo/Yr): Oct 96

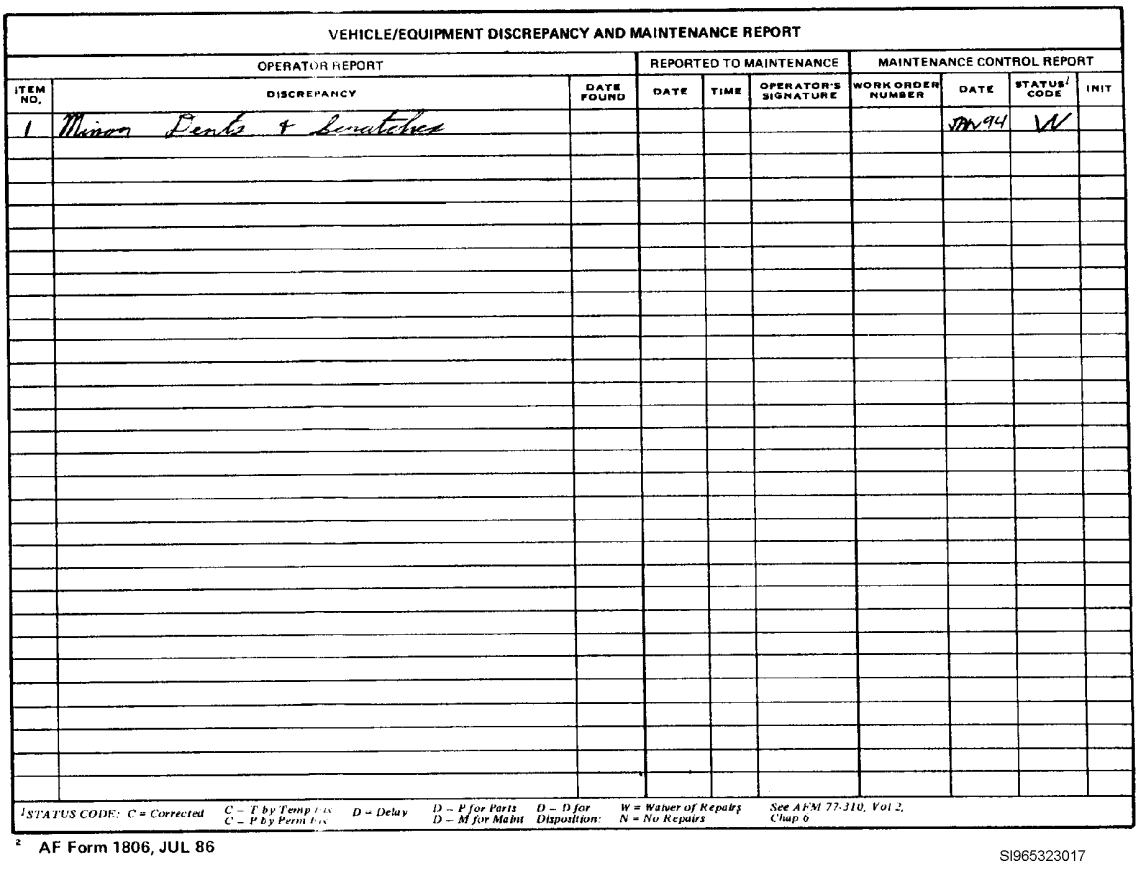
VEHICLE TYPE	REGISTRATION NUMBER	
Hi REACH	94 C 127	
USING ORGANIZATION	LOCATION	PHONE NUMBER
366 TRS	SAFB TX	6-5854
NAME OF VEHICLE CONTROL OFFICER	GRADE	PHONE NUMBER
JAMES TOOTHILL	MSGT	6-5854

ITEMS TO BE CHECKED	OPERATOR SIGNATURE	DAY
1. CLEANLINESS/DAMAGE/MISSING ITEMS (interior/exterior)		1
2. LEAKS (fuel/oil/coolant/hydraulic/air)		2
3. LEVELS (fuel/oil/coolant/hydraulic)		3
4. BATTERIES (front/rear) FLUID LEVEL/DAMAGE/CLEANLINESS		4
5. DRIVE BELTS/PULLEY/MOTOR (air/hydraulic/electrical)		5
6. STEERING/SPRINGS/SHACKLES		6
7. WINCH/TOW CONNECTIONS		7
8. TIRES/WHEELS/TRACK		8
9. PUMPS/PIPING/SPARE BARS		9
10. BROOMS/SPROCKETS/CHAINS		10
11. EXHAUST SYSTEM/SPARK ARRESTORS		11
12. MOULDBOARDS/BOWLS/CUTTING EDGES		12
13. SHEAVES/BLOCKS/CABLES		13
14. CHUTES/AUGERS/FAN BLADES WEARSHOES		14
15. DRUMS/CROWNS/FAIRLEADS		15
16. BOOMS/OUTRIGGERS (check for cracks & damage)		16
17. BASKET/PLATFORM/TURNTABLE (check for cracks & damage)		17
18. BLADE/REELS/SICKLE BARS		18
19. KETTLE/HOISTING MECHANISM/AGITATORS		19
20. AUXILIARY GENERATOR/HEATER		20
21. WIRING/LIGHTS/HORN/REFLECTORS/MIRRORS		21
22. WINDSHIELD WIPERS/WASHERS		22

AF Form 1806, JUL 86 — REPLACES AFTO 373, JAN 74 WHICH WILL BE USED — 1

SI965323016

Figure 1, Front and Back of AF Form 1806, Operator's Inspection Guide and Trouble Report (Aircraft Towing, Base Maintenance, Deicers, High Reach and Snow Removal).



VEHICLE/EQUIPMENT DISCREPANCY AND MAINTENANCE REPORT

OPERATOR REPORT			REPORTED TO MAINTENANCE			MAINTENANCE CONTROL REPORT			
ITEM NO.	DISCREPANCY	DATE FOUND	DATE	TIME	OPERATOR'S SIGNATURE	WORK ORDER NUMBER	DATE	STATUS[1] CODE	INIT
1	Minor Dents & Scratches						MAY 94	W	

[1]STATUS CODE: C = Corrected; C – T by Temp Fix; C – P by Permanent Fix; D = Delay; D – P for Parts; D – M for Maint; D – D for Disposition; W = Waiver of Repairs; N = No Repairs; See AFM 77-310, Vol 2, Chap 6

[2] AF Form 1806, JUL 86

SI965323017

Figure 2, Front and Back of AF Form 1806, Operator's Inspection Guide and Trouble Report (Aircraft Towing, Base Maintenance, Deicers, High Reach and Snow Removal).

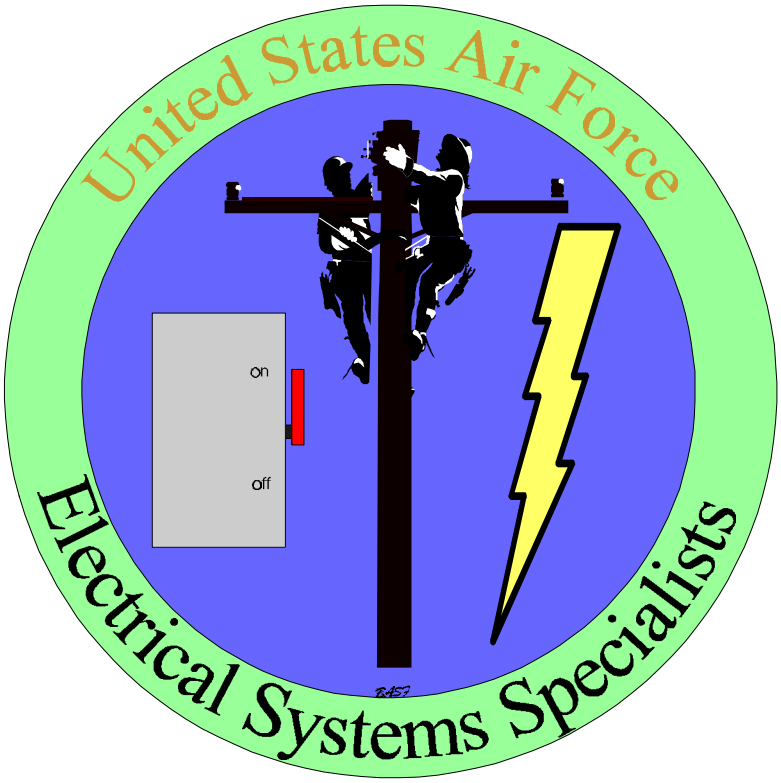
Review Questions
for
Perform Operator's Maintenance on High Reach Truck with Insulated Bucket

Question	Answer
1. What AF Form is used to annotate discrepancies found on the high reach truck?	a. 1000 b. 623 c. 1806 d. 1800
2. The three operational checks made on the high reach truck are Pre-operational, Operational, and Post-operational.	a. True b. False
3. What operational check is made while the vehicle or auxiliary equipment is in use?	a. Pre-operational b. Operational c. Post- operational d. All of the above
4. What check lets the operator identify any damage that may have been overlooked during the day's work?	a. Pre-operational b. Operational c. Post-operational d. All of the above
5. Which of the following problems CAN NOT arise from low tire pressure?	a. Uneven tire wear b. Inability to control vehicle c. Broken valve stems d. A and B
6. How often is tire pressure checked and where is it annotated?	a. Once a day / 1806 b. Monthly / 1800 c. Once a day / 1800 d. Monthly / 1806

PERFORM OPERATOR'S MAINTENANCE ON HIGH REACH TRUCK WITH INSULATED BUCKET

Performance Checklist		
Step	**Yes**	**No**
1. Does the trainee know the three types of inspections that should be performed?		
2. Did trainee perform all steps associated with the pre-operational inspection?		
3. Did trainee perform operational inspections?		
4. Can trainee properly perform a post-operational inspection?		
5. Does trainee know the proper way to report and annotate discrepancies when found?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 **AFQTP UNIT 7**

PERFORM OPERATOR'S MAINTENANCE ON LINE MAINTENANCE TRUCK (24.7.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

PERFORM OPERATOR'S MAINTENANCE ON LINE MAINTENANCE TRUCK

Task Training Guide

STS Reference Number/Title:	24.7. – Tools and equipment, perform operator's maintenance on line maintenance truck
Training References:	• CDC 3E051 Set B Vol. 1 • AFI 32-1064, Electrical Safe Practices • T.O. 36A12-5-1-181 and 182 • AFI 24-301, Vehicle Operations
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Line Maintenance Truck, Leather Gloves, Hard Hat, AF Form 1806
Learning Objective:	• Given equipment, perform operator's maintenance on a line maintenance truck
Samples of Behavior:	• Following approved steps, perform operator's maintenance on a line maintenance truck • Know safety requirements for performing operator's maintenance
Notes:	
• Any safety violation is an automatic failure.	

PERFORM OPERATOR'S MAINTENANCE ON LINE MAINTENANCE TRUCK

Background: Special-purpose vehicles for power line work have greatly reduced the physical labor that once was required in this work. One person operating the power supplied by the truck has the physical strength of several people working with hand tools. As with almost everything else however, accidents can happen. In the process of investigating bucket truck accidents over a period of years, it became clear that operator error and/or lack of proper maintenance were primary reasons for these accidents. We'll talk about these areas of operator safety and operating instructions in this unit.

The Air Force has invested a great deal of money in maintenance trucks. Ensuring that the equipment has the proper care protects this investment, which makes your job easier. Let's look at a few of the pre-operation inspection items you should check before operating the maintenance truck.

To perform the task, follow these steps:

Step 1: Pre-operational check.

- Check them daily and note any discrepancies in AF Form 1806, Operator's Inspection Guide and Trouble Report (Aircraft Towing, Base Maintenance, Deicers, High Reach and Snow Removal).
- The operator maintains things such as cleanliness, tire pressure, battery water, fuel, oil, and coolant levels.
- For all other discrepancies, turn the truck into the motor pool for repair as soon as possible.
- Now check the actual AF Form 1806 in Figures 1 and 2 as we clarify particular inspection items on the form.
- Check for damage, such as damaged or missing external or internal components.
- Check for oil, fuel, and hydraulic leaks.
- Keep tire pressure at the level stenciled on the inside of the door on the driver's side of the truck.
- Since tires are changed at the motor pool, there are no spare tires, jacks, or lug wrenches with the truck.
- The operator keeps proper levels of fuel, oil, and coolant.
- Check the battery terminals for tightness and cleanliness, and check the water level in each cell.
- Check the horn for proper operation.
- Make sure all lights work and that the reflectors aren't broken.
- Check the instruments and see that the windshield wipers work properly and the blades are in good condition.
- If there are windshield washers, be sure the reservoir is full and they operate properly.
- Clean the windshield—especially if it's covered with hydraulic fluid or tree sap from tree trimming.
- Cargo and mounted equipment checks include booms, buckets, front jacks, rear jacks, and the controls.

- Clean the vehicle inside and out—at least once a week or as needed for proper cleanliness.
- The truck must also be waxed periodically.
- Check the steering for looseness, wandering, or shimmying.
- Check the power steering fluid, if there is any.
- Make sure all safety devices are intact and operating properly.
- Check the fan, generator, power steering, hydraulic pump, and air compressor drive belts and pulleys and the cable pulleys on the booms.
- Check the brakes for pulling, grabbing, or softness.
- The motor pool should change the oil and lubricate the truck periodically.

Step 2: Operational check.

- The operational inspection is made while the vehicle or auxiliary equipment is in use.
- Check for noises such as metal screeching against metal, loose belts, or odd engine noises.

NOTE:
Things like this can only be identified while the vehicle or equipment is in use.

- Checking for leaks is easy because of the pressure generated by the pumps.
- During operation, inspect all hydraulic connections for visible leaks.
- Also check oil levels of the hydraulic system during operation, and check the hydraulic reservoir site glass periodically.
- If the oil drops below the site glass, stop operation and fill the system tank.
- Absence of fluid in the tank will cause strain and damage to truck equipment.
- Continually check the gauges to ensure correct hydraulic pressure to protect the equipment.
- Make sure there's enough fuel to complete the job.

NOTE:
The most important gauge to watch is the tachometer. Don't exceed the manufacturer's specifications for maximum engine revolutions per minute (rpm).

Step 3: Post-operational checks.

- Make the post-op check every time you've finished with the vehicle for the day, and before storing the truck.
- This lets you identify any damage, minor or major, that may have been overlooked during the day's work.
- Note any discrepancies during the pre-op, operational, or post-op checks and annotate your findings on AF Form 1806.
- Notify your supervisor and then turn the truck into the motor pool for repair.

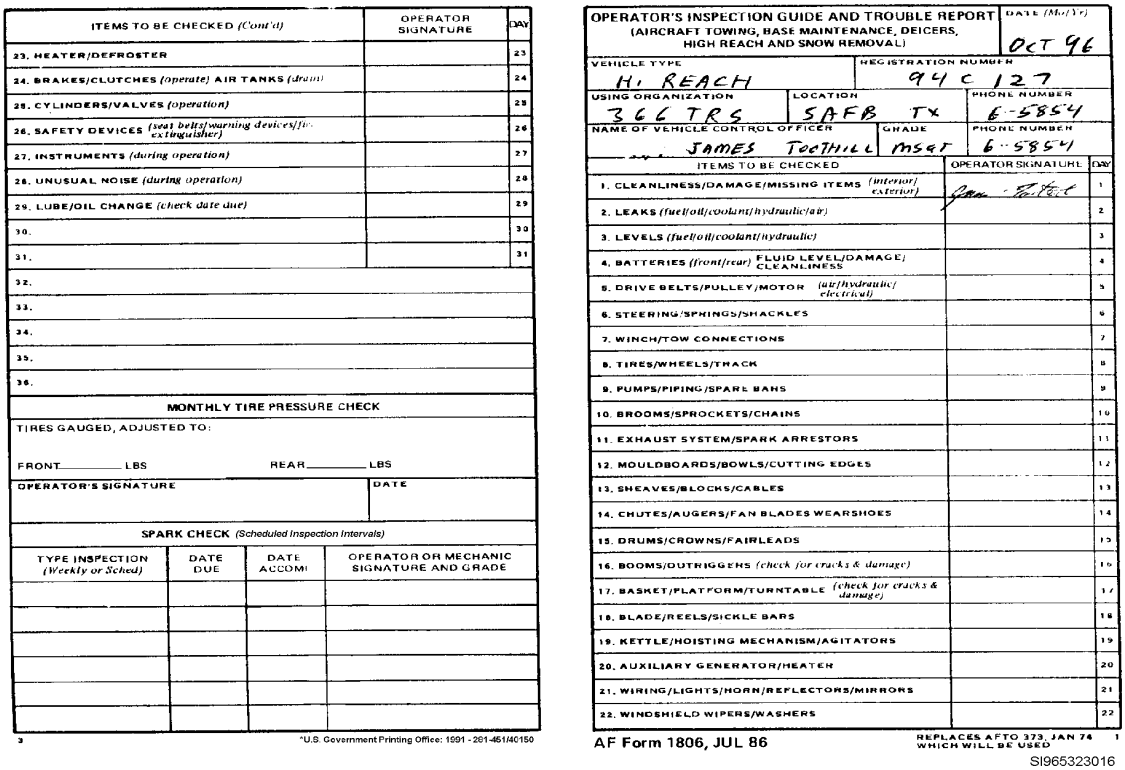
Step 4: Maintenance checks.

- Every vehicle requires a certain amount of maintenance to keep it running properly. Our trucks are no different.
- Wash the vehicle at least once a week and wax it once a month. Camouflaged vehicles usually don't require waxing.

- As the operator of an Air Force-owned vehicle, you're responsible for all fluid levels, so be sure to add oil, windshield washer fluid, and battery fluid as necessary. Identify low coolant levels to the motor pool, because they're the only people authorized to add coolant. Maintaining fluid levels help prevent premature vehicle breakdown, and it may end up saving all of us a little money.
- Low tire pressure can cause a number of problems, ranging anywhere from uneven tire wear to inability to control the vehicle. There is a space on AF Form 1806 to annotate the tire pressure. Check it at least monthly.
- You maintain the truck's winches. Keep the winch cables lubricated to prevent corrosion, and repair or replace any frayed or damaged cable.
- It's very important to read the operation and maintenance manuals before you operate your utility vehicles. Study them carefully so that you'll meet safety requirements and vehicle maintenance requirements.

Step 5: Rental units.

- Notify the BCE if the insulated personnel lifting device becomes inoperable and the estimated return-to-service date are more than 10 days.
- Upon notification, the BCE should forward a request to the Transportation Squadron Fleet Manager for rental/lease vehicle support.
- Rental vehicles must be thoroughly inspected and tested before initial use.



ITEMS TO BE CHECKED (Cont'd)	OPERATOR SIGNATURE	DAY
23. HEATER/DEFROSTER		23
24. BRAKES/CLUTCHES (operate) AIR TANKS (drain)		24
25. CYLINDERS/VALVES (operation)		25
26. SAFETY DEVICES (seat belts/warning devices/fire extinguisher)		26
27. INSTRUMENTS (during operation)		27
28. UNUSUAL NOISE (during operation)		28
29. LUBE/OIL CHANGE (check date due)		29
30.		30
31.		31
32.		
33.		
34.		
35.		
36.		

MONTHLY TIRE PRESSURE CHECK

TIRES GAUGED, ADJUSTED TO:

FRONT_____ LBS REAR_____ LBS

OPERATOR'S SIGNATURE	DATE

SPARK CHECK (Scheduled Inspection Intervals)

TYPE INSPECTION (Weekly or Sched)	DATE DUE	DATE ACCOM	OPERATOR OR MECHANIC SIGNATURE AND GRADE

3 *U.S. Government Printing Office: 1991 - 281-461/40150

OPERATOR'S INSPECTION GUIDE AND TROUBLE REPORT (AIRCRAFT TOWING, BASE MAINTENANCE, DEICERS, HIGH REACH AND SNOW REMOVAL) DATE (Mo/Yr): OCT 96

VEHICLE TYPE	REGISTRATION NUMBER
HI REACH	94 C 127

USING ORGANIZATION	LOCATION	PHONE NUMBER
366 TRS	SAFB TX	E-5854

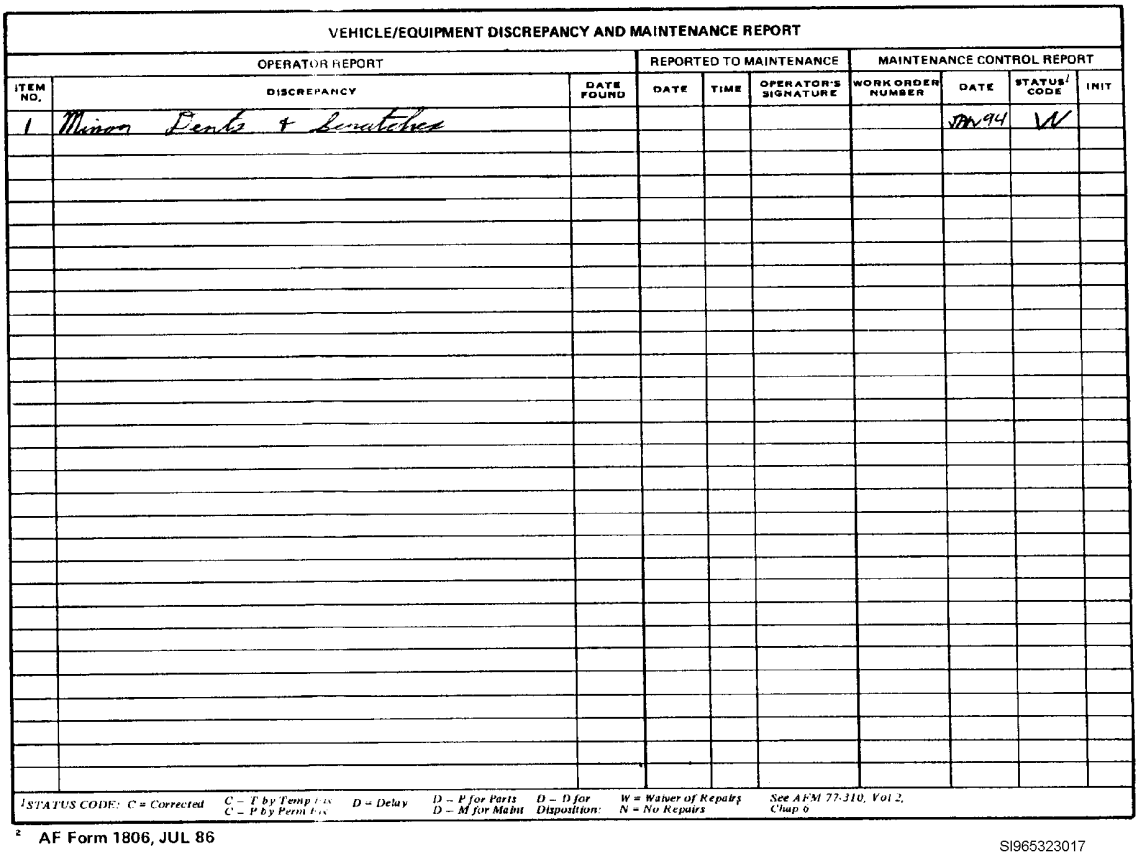
NAME OF VEHICLE CONTROL OFFICER	GRADE	PHONE NUMBER
SSG JAMES TOOTHILL	MSGT	6-5854

ITEMS TO BE CHECKED	OPERATOR SIGNATURE	DAY
1. CLEANLINESS/DAMAGE/MISSING ITEMS (interior/exterior)		1
2. LEAKS (fuel/oil/coolant/hydraulic/air)		2
3. LEVELS (fuel/oil/coolant/hydraulic)		3
4. BATTERIES (front/rear) FLUID LEVEL/DAMAGE/CLEANLINESS		4
5. DRIVE BELTS/PULLEY/MOTOR (air/hydraulic/electrical)		5
6. STEERING/SPRINGS/SHACKLES		6
7. WINCH/TOW CONNECTIONS		7
8. TIRES/WHEELS/TRACK		8
9. PUMPS/PIPING/SPARE BANS		9
10. BROOMS/SPROCKETS/CHAINS		10
11. EXHAUST SYSTEM/SPARK ARRESTORS		11
12. MOULDBOARDS/BOWLS/CUTTING EDGES		12
13. SHEAVES/BLOCKS/CABLES		13
14. CHUTES/AUGERS/FAN BLADES WEARSHOES		14
15. DRUMS/CROWNS/FAIRLEADS		15
16. BOOMS/OUTRIGGERS (check for cracks & damage)		16
17. BASKET/PLATFORM/TURNTABLE (check for cracks & damage)		17
18. BLADE/REELS/SICKLE BARS		18
19. KETTLE/HOISTING MECHANISM/AGITATORS		19
20. AUXILIARY GENERATOR/HEATER		20
21. WIRING/LIGHTS/HORN/REFLECTORS/MIRRORS		21
22. WINDSHIELD WIPERS/WASHERS		22

AF Form 1806, JUL 86 REPLACES AFTO 373, JAN 74 WHICH WILL BE USED 1

SI965323016

Figure 1, AF Form 1806, Front and Back, Operator's Inspection Guide and Trouble Report (Aircraft Towing, Base Maintenance, Deicers, High Reach and Snow Removal).



VEHICLE/EQUIPMENT DISCREPANCY AND MAINTENANCE REPORT

OPERATOR REPORT			REPORTED TO MAINTENANCE			MAINTENANCE CONTROL REPORT			
ITEM NO.	DISCREPANCY	DATE FOUND	DATE	TIME	OPERATOR'S SIGNATURE	WORK ORDER NUMBER	DATE	STATUS[1] CODE	INIT
1	Minor Dents & Scratches						JAN 94	W	

[1] STATUS CODE: C = Corrected; C – T by Temp Fix; C – P by Perm Fix; D = Delay; D – P for Parts; D – M for Maint; D – D for Disposition; W = Waiver of Repairs; N = No Repairs; See AFM 77-310, Vol 2, Chap 6

[2] AF Form 1806, JUL 86

SI965323017

Figure 2, AF Form 1806, Inside, Operator's Inspection Guide and Trouble Report (Aircraft Towing, Base Maintenance, Deicers, High Reach and Snow Removal).

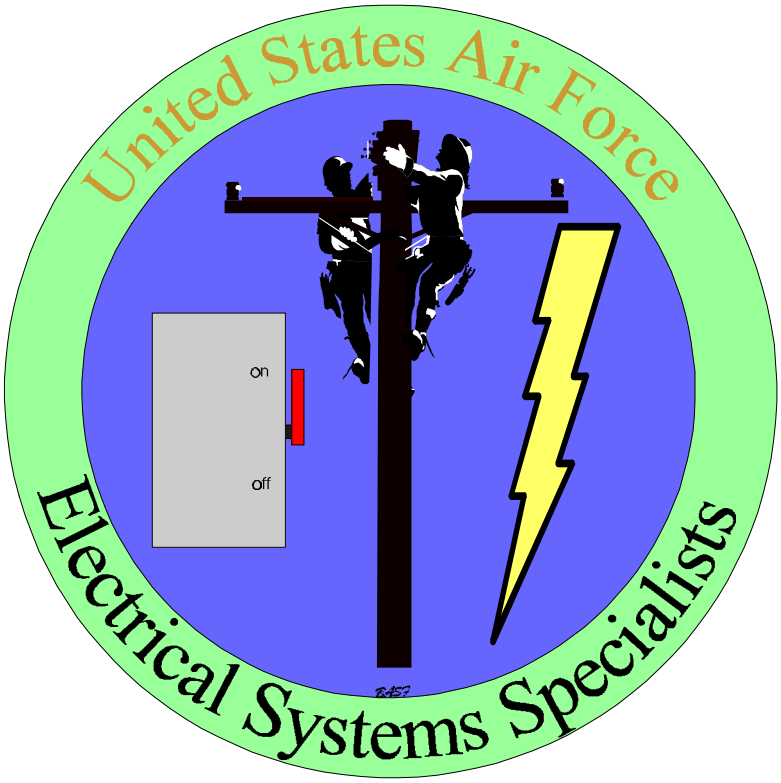
Review Questions
for
Perform Operator's Maintenance on Line Maintenance Truck

Question	Answer
1. What AF Form is used to annotate discrepancies found on the line maintenance truck?	a. 1000 b. 623 c. 1806 d. 1800
2. The three operational checks made on the line maintenance truck are Pre-operational, Operational, Post operational.	a. True b. False
3. What operational check is made while the vehicle or auxiliary equipment is in use?	a. Pre-operational b. Operational c. Post- operational d. All of the above
4. What check lets the operator identify any damage that may have been overlooked during the day's work?	a. Pre-operational b. Operational c. Post-operational d. All of the above
5. Which of the following problems CAN arise from low tire pressure?	a. Uneven tire wear b. Inability to control vehicle c. Broken valve stems d. A and B
6. How often is tire pressure checked and where is it annotated?	a. Once a day / 1806 b. Monthly / 1806 c. Once a day / 1800 d. Monthly / 1800
7. Whose responsibility is it to maintain line truck fluid levels?	a. Supervisor b. Vehicle NCO c. Operator d. Motor pool

PERFORM OPERATOR'S MAINTENANCE ON LINE MAINTENANCE TRUCK

Performance Checklist		
Step	**Yes**	**No**
1. Does the trainee know the three types of inspections that should be performed?		
2. Did trainee perform all steps associated with the pre-operational inspection?		
3. Did trainee perform operational inspections?		
4. Can trainee properly perform a post-operational inspection?		
5. Does trainee know the proper way to report and annotate discrepancies when found?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 **AFQTP UNIT 8**

OPERATE HIGH REACH CONTROLS (24.8.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

OPERATE HIGH REACH CONTROLS

Task Training Guide

STS Reference Number/Title:	24.8. – Tools and equipment, operate high reach controls
Training References:	• CDC 3E051B, Vol. 1 • AFI 32-1064, Electrical Safe Practices • T.O. 36A12-5-1-181 and 182 • AFI 24-301, Vehicle Operations
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• High Reach Truck, Leather Gloves, Hard Hat,
Learning Objective:	• Given equipment, operate high reach controls
Samples of Behavior:	• Following approved steps, operate high reach controls • Know safety requirements for operating high reach controls
Notes:	
• Any safety violation is an automatic failure.	

OPERATE HIGH REACH CONTROLS

Background: This lesson covers the operation of hydraulic booms with aerial baskets in electric maintenance work. Lift controls must be tested each day before use to make sure they're in safe working condition. The insulated part of an aerial lift must not be altered in any way that might reduce its insulating value. The vehicle may become energized (or grounded) when the boom or the aerial basket itself comes in direct contact with energized (or grounded) conductors or equipment. Never depend on the truck, the boom, or the aerial basket to be Electrically Insulated. Don't let anyone touch the truck or equipment when aerial equipment is operating in or near energized conductors. The vehicle must be grounded or considered as energized and barricaded. The rules governing use of rubber or other protective equipment while working on poles and structures also apply to work from aerial baskets. You must use a body belt with a secured safety strap (or approved equivalent) for any work from an aerial basket, and it must be attached to the boom. Basket liners must be used (if the basket is designed to be used with a liner) and tested according to TO 36C–1–4, *Dielectric Testing of Insulated Aerial Manlift Devices.* Anyone working from an aerial basket or on the ground near one must wear a safety hat and suitable clothing at all times. Don't let unauthorized or unqualified people operate the boom carrying an aerial basket. Insulated aerial lifting devices used for working on energized electrical systems must be specifically designed for that sole function. The aerial lift must be used only for electrical related work. The manufacturers load limits of the boom or baskets must be posted on the unit, and they must not be exceeded. All hydraulic and pneumatic tools used on or near energized equipment must have non-conducting hoses rated for normal operating pressure. An aerial crew must include at least two qualified workers.

Travel procedures.

- Drivers of aerial basket trucks must be constantly alert to the fact the vehicle has exposed equipment above the elevation of the truck cab and provide the necessary clearance.
- Moving the truck into the opposing traffic stream is hazardous and must be avoided when possible by planning the order of the work.
- Any backing of the truck must be done slowly and under the direction of one person, on the ground, with an unobstructed view of the intended path and the driver.
- Never move a truck with the boom elevated in working position.
- When you're traveling to and from job sites, either remove pin-on-type buckets and store them on the truck or secure them in a horizontal position to keep from obstructing the driver's vision.

Setting up and knocking down at the job site.

- At the work area, the truck must be parked legally while the vehicle and pedestrian warning signs, lights, and barricades are being placed.
- Give careful consideration to the location of overhead conductors and the surrounding conditions before the truck is moved into the work position.
- Make every effort to place the truck so that the boom without moving the truck may reach all work areas at that location.
- Carefully examine the footing available for the truck wheels and outriggers, and take extra caution if there is snow, ice, mud, soft ground, or other unusual conditions.

- You must consider blind ditches, manholes, culverts, cesspools, wells and similar construction as additional possible hazards.
- Before lowering the stabilizers, outriggers, or hydraulic jacks, the operator must be sure that no one is close enough to be injured.
- Chocks or cribbing may be needed to stabilize the truck body.
- On an inclined road or street, check each outrigger or jack to ensure a stable setup, with the truck approximately level as viewed from the rear.
- A warm-up period is needed at the beginning of each day's work.

NOTE:
This time may vary with different makes, models, and ambient temperature ranges.

- When work is complete, lower the bucket, cradle the boom, and secure them by an approved tie-down.
- Everyone must stand clear as the bucket and boom are being lowered to a cradled position.

SAFETY:
WE'LL CONSIDER BUCKET OPERATION IN FOUR AREAS: BEFORE RAISING THE BUCKET, RAISING THE BUCKET, WORKING ALOFT, AND GROUND OPERATION. THIS IS A VERY HAZARDOUS PART OF YOUR DUTIES. "READ AND HEED."

Before operating the boom.

- One person must be responsible for everything required to place the basket in operating position, use the bucket, and restore it to the traveling position.
- The operator must check to be sure that the outriggers or stabilizers are down, the truck hand brake is set, and the rear wheels of the truck chalked, if necessary.
- The outriggers or stabilizers must be checked for safe operation before a load is lifted if the operator has any doubt as to the stability of the truck due to terrain.
- When the boom must be maneuvered over a street or highway, necessary precautions must be taken to avoid accidents with traffic or pedestrians.

Enter the bucket only when the bucket is in the position for which it is designed.

- **Operate the boom.**
- Note the location of all obstructions, so that neither the bucket nor the boom will contact them in raising, lowering, or rotating.
- The operator should always face the direction in which the bucket is moving.
- The operator must follow the sequence prescribed by the manufacturer in raising the boom section.
- Before reaching any area that has obstructions, the operator must test the boom and bucket controls and suspend operations if the unit isn't working properly.
- Raise the bucket directly above energized conductors or equipment only when it's ABSOLUTELY NECESSARY.

Working aloft.

- Buckets should be located under or to the side and must not contact any conductors or equipment.

- Any worker who must get within reach of energized conductors or equipment must wear proper primary rubber gloves and rubber sleeves.
- Cover energized conductors and equipment with protective devices if that's necessary to work safely.
- Maintain adequate clearance so that protruding tools won't contact conductors, limbs, or other obstructions.
- The worker must not stand on top of the bucket or on planks across the top of the bucket during work.
- The worker must not belt into an adjacent pole, structure, or equipment while working from the basket.
- The operator must make sure that handlines and tools don't become entangled with the levers that operate the boom.
- When you're working aloft, secure all tools that aren't in use.

Ground operations.

- When the bucket is being used in any way that might make the basket, boom, or anything attached to them contact an energized conductor, consider the vehicle energized at line potential, and follow these safe practices:
- Never pass materials or tools between a worker on the vehicle and a worker on the ground unless both workers wear primary rubber gloves and use the other required protective devices.
- Employees operating ground controls must be on the vehicle or insulated from the ground by using primary rubber gloves and other protective equipment.
- Before entering or leaving the vehicle, the employee must make sure that the boom or bucket isn't in contact or near energized equipment.
- Workers on the ground must not work directly below the work area of the bucket.
- Don't throw tools or materials to or from the elevated basket.

To perform this task, follow these steps:

- ***Refer to owner's manual for operating instructions on your particular vehicle.***

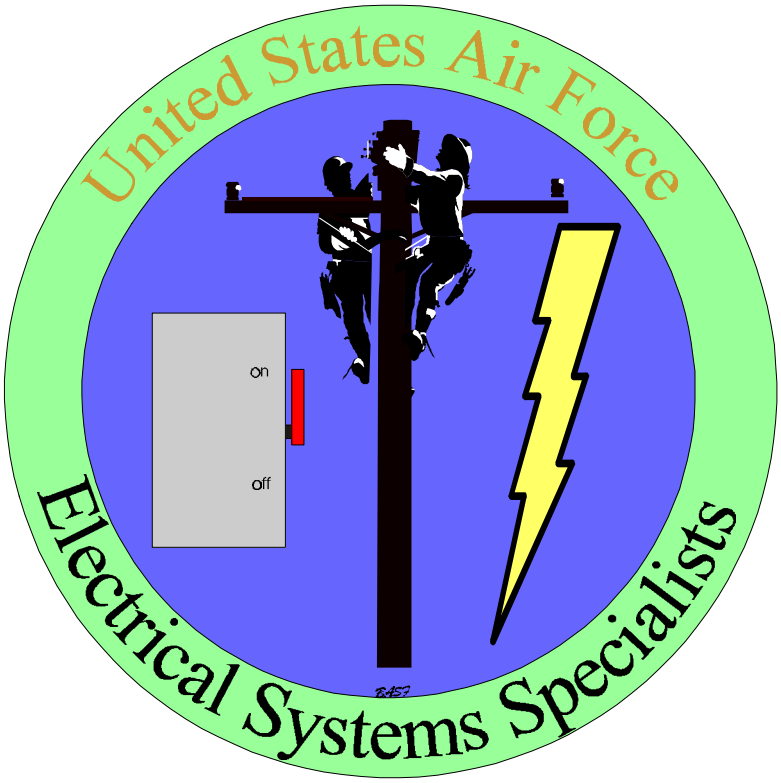
Review Questions
for
Operate High Reach Controls

Question	Answer
1. How many people make up an aerial crew?	a. At least 1qualified worker b. At least 2 qualified workers c. At least 3 qualified workers d. At least 4 qualified workers
2. The operator must make sure no one is close enough to the truck to get hurt when _____.	a. Checking the hydraulic fluid True b. Moving into opposing traffic c. Lowering the stabilizers d. All of the above
3. What safety equipment must be worn when working on or around a bucket truck?	a. Hard hat b. Suitable clothing c. c. both a & b
4. When working aloft the bucket should be positioned _____ or to the _____ and must not contact any installed equipment.	a. Over / Front b. Under / Rear c. Under/ Side d. Over / Rear
5. The worker must use any means necessary to reach work positions, even if it includes standing on top of the bucket or on planks across the top of the bucket.	a. True b. False

OPERATE HIGH REACH CONTROLS

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee operate and identify aerial lift controls?		
2. Did trainee properly set up vehicle?		
3. Can trainee explain the safety factors associated with operating the high reach controls?		
4. Can trainee operate bucket controls smoothly and safely?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 AFQTP UNIT 9

OPERATE LINE MAINTENANCE TRUCK CONTROLS (24.9.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

OPERATE LINE MAINTENANCE TRUCK CONTROLS

Task Training Guide

STS Reference Number/Title:	24.9. – Tools and equipment, operate line maintenance truck controls
Training References:	• CDC 3E051B vol. 1 • AFI 32-1064, Electrical Safe Practices • T.O. 36A12-5-1-181 and 182 • AFI 24-301, Vehicle Operations • CerTest Tape #1.7.56.“Hydraulic Derricks and Digging Equipment”
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Line Maintenance Truck, Leather Gloves, Hard Hat,
Learning Objective:	• Given equipment, operate line maintenance truck controls
Samples of Behavior:	• Following approved steps, operate line maintenance controls • Know safety requirements for operating line maintenance controls
Notes:	
• Any safety violation is an automatic failure.	

OPERATE LINE MAINTENANCE TRUCK CONTROLS

Background: The line truck is used to construct and maintain electrical distribution lines. Most line trucks have a compartment body, a power- driven winch, capstan, tow hooks, boom, auger, and body support jacks.

Compartments.

- There are bins on the line truck for your tools, equipment, and materials.
- Keep each item in its place, and carry at least a 1-day supply of hardware such as bolts, lag screws, connectors, and tape.
- The equipment you'll need for electric line work is also stored on the line truck.

Power-driven winch.

- The winch is operated through the truck power takeoff.
- Most line trucks have two winch drums, one in front and the other tied in with the boom operation.
- Both winch drums have automatic brakes to keep the winch from turning when it's under load.
- You can release the brakes when the engine is running and the power takeoff unit is engaged.
- Don't exceed the truck and winch line load limitations stated in the manufacturer's load capacity chart.
- The winch must lift 15,000 pounds safely with the cable on bare drum wrap layer, and 6,000 pounds with a full drum.
- For loads less than 10,000 pounds, 1/2-inch wire rope is sufficient; for loads over 10,000 pounds, use 5/8 IWRC 6 by 19 VHS cable.
- Avoid stacking the winch line and jerking the load.
- Consider using nonconductive winch (fabric) for the line truck.

NOTE:
In addition to not conducting electricity, the nonconductive winch has no steel strands to cut skin and it's lighter, and more manageable to work with.

Boom.

- The boom and winch are used to raise and set, pull and lower poles; load and unload poles from the pole trailer; and load, unload, raise, or lower pole line equipment such as transformers.
- Read and understand all operation instructions before you operate the boom or any other part of the truck.
- Operating the line truck can be extremely hazardous if you don't know what you're doing.
- All winch and boom operation takes at least two people: an operator and a spotter, who gives signals.

- On a crown or slope, position the truck so that you work on the high side, avoid soft ground and overhead obstructions, and set the parking brake.

- To engage the power takeoff (PTO) with standard transmission, push in the clutch, place the truck in neutral, engage the PTO, and then release the clutch.
- If your truck has a transfer case, you push in the clutch, put the transfer case in neutral, and engage PTO; then you put the transmission in fourth gear and let out the clutch.
- Never operate the boom without lowering the jacks until the tires are almost off the ground and leveling the truck bed by raising the high side jacks.
- Level the truck to within 15 percent grade (8 1/2°) for lifting to prevent boom side overload.
- If there's a question about soft ground, hot asphalt, or weak pavement, use planks of sufficient area and strength under jack pads.
- Some trucks have a safety switch to prevent boom operation if the jacks aren't all the way down.
- Check the operator's manual for override procedures if necessary.
- The digging auger and fiberglass boom extension are normally attached to the line maintenance truck boom. The hydraulic auger can dig holes ranging from 12 inches to 36 inches in diameter and up to 12 feet deep.

Boom precautions.

- The fiberglass boom with attached buckets lets you work on energized circuits. The buckets alone have no insulating value, so they have polyethylene liners.
- Don't operate the boom when winds exceed 30 mph (26 knots).
- Don't operate steel booms within 15 feet of energized overhead lines.
- Don't pull poles out of the ground with derrick booms.
- Don't pull side loads with the boom.
- When you're dragging poles, line up the boom with the winch cable.
- Don't pull stumps with the boom and winch (use a pole jack).
- Don't rock a pole with the boom to loosen it in the hole.
- When you're using the fiberglass boom to work on energized circuits, remove the boom winch line.
- Don't use buckets without polyethylene liners.
- Don't exceed the maximum rated load of the boom, winch, or buckets.

Capstan.

- The capstan is used for raising loads like transformers, pulling slack in conductors, or holding a strain.
- Wind the rope clockwise on the capstan, as shown in Figure 1, with the load end next to the truck.
- Keep the load at a 90° angle to the capstan so that the rope won't climb the flange or bind at the turns.
- Vary the number of turns of rope from three to six or more, depending on the load weight.
- The capstan turns clockwise to raise a load, and it stops for lowering heavy loads.
- To pick up a load, gradually increase the strain on the free end of the rope until the load is being reeled in at the rate you want.

- Lessen the strain to slow or stop the load pickup.

- Stopping the capstan and providing a controlled amount of slack will let you lower the load.
- Always keep the free end of the rope in the clear.
- Don't stand on the free end or let it tangle around your feet.
- A wet rope sticks, slips, or binds, and makes it hard to lower or hold a load.
- An oily rope slips too fast, letting a load lower too fast.

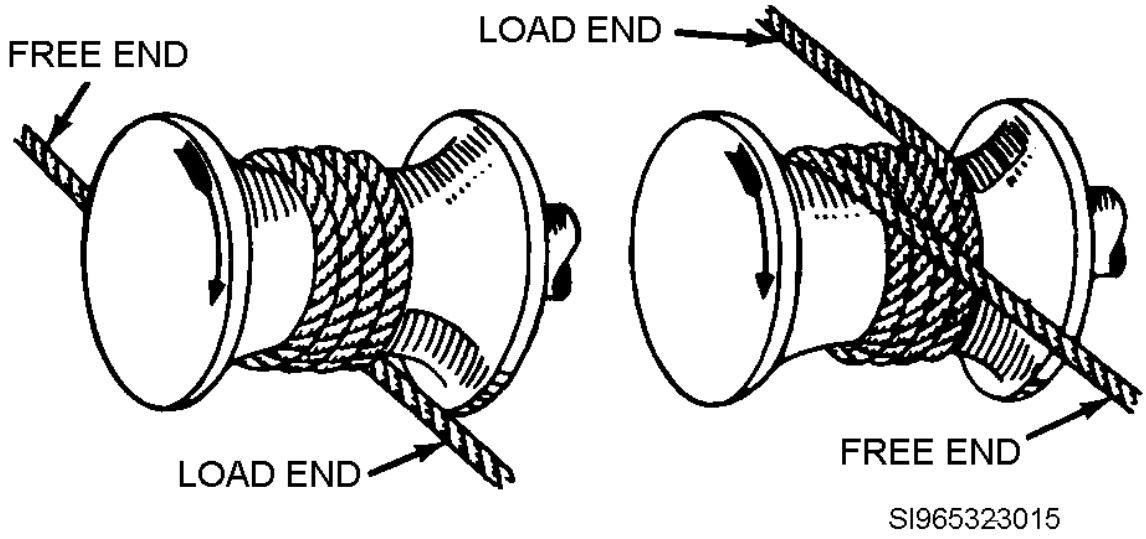


Figure 1, Capstan

To perform this task, follow these steps:

- ***Refer to owner's manual for operating instructions on your particular vehicle.***

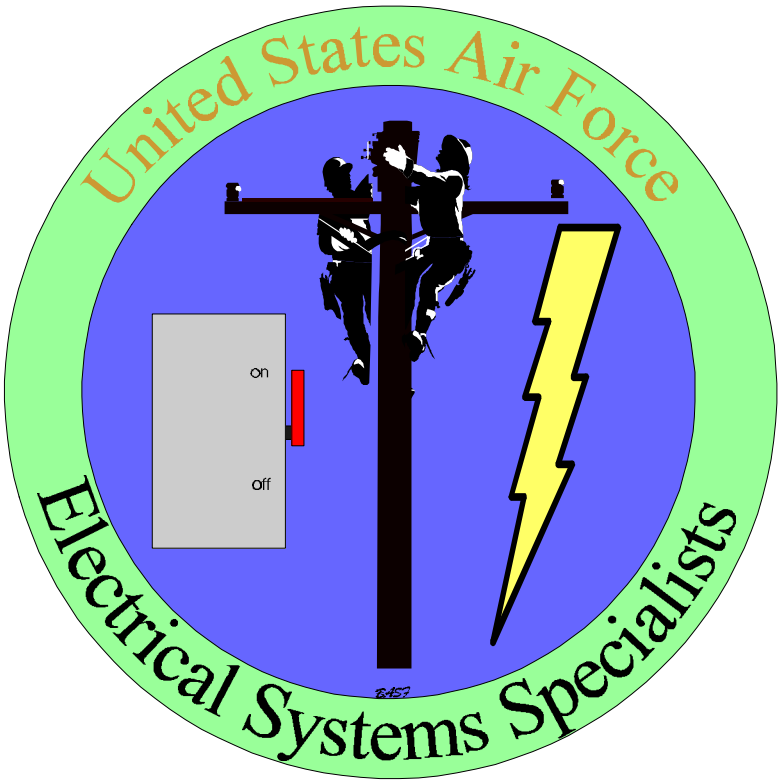
Review Questions
for
Operate Line Maintenance Truck Controls

Question	Answer
1. What size winch cable will handle loads of less than 10,00 pounds?	a. 1/2 inch wire rope b. 3/8 inch wire rope c. 5/8 inch wire rope d. 1 inch wire rope
2. What is the advantage of using fabric winch cable instead of a wire rope cable?	a. Cheaper in cost b. Stronger than steel c. Last longer d. No steel strands to cut the skin
3. What can you do if the line truck must be set up on hot asphalt or soft ground?	a. Leave outriggers barely off the ground b. Set up the truck as normal c. Place planks under jack pads d. Place 6'X8' bricks under outriggers
4. What piece of equipment is used to pull a pole?	a. Capstan b. Pole jaws c. Winch lines d. Pole jacks
5. How do you compensate for various loads while using capstan?	a. Vary turns by 3 b. Vary turns by 6 c. Vary turns by 9 d. All of the above

OPERATE LINE MAINTENANCE TRUCK CONTROLS

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee identify major working parts of the line truck?		
2. Can trainee explain the factors to be considered when operating the line truck?		
3. Can trainee explain factors to be considered when positioning the line truck?		
4. Can trainee demonstrate proper techniques for moving material?		
5. Can trainee operate and identify line truck controls?		
6. Did trainee properly set up vehicle?		
7. Can trainee explain the safety factors associated with operating the high reach controls?		
8. Can trainee operate bucket controls smoothly and safely?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 **AFQTP UNIT 12**

USE MANUAL CONDUIT BENDERS (24.12.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

USE MANUAL CONDUIT BENDERS

Task Training Guide

STS Reference Number/Title:	24.12. – Tools and equipment, use manual conduit benders
Training References:	• CDC 3E051A vol. 4 • AFI 32-1064, Electrical Safe Practices
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Rigid and EMT conduit benders • Rigid and EMT conduit • Tape measure, and marker
Learning Objective:	• Given equipment, use manual conduit benders
Samples of Behavior:	• Following approved procedures, bend rigid and EMT conduit while properly operating manual conduit benders • Know safety requirements for using manual conduit benders
Notes:	
• Any safety violation is an automatic failure.	

USE MANUAL CONDUIT BENDERS

- **Background:** One of the tasks you'll have as an electrical technician is to make field bends in conduit. Although conduit bending is thought by many electricians to be quite difficult, it is really fairly simple. It does require some thought, simple math calculations, and a lot of practice. But it is like swimming—once you have learned how, you never forget.

    - When you install conduit, make bends to go over or around obstacles. These bends must be made without reducing the inside diameter of the conduit at the bend. You'll make most bends on the job as a part of the installation procedure. These are called field bends. Factory-made bends may be used instead of field bends; however, they increase the cost of the job because they require more cutting, threading, and bending. Since most of the bending you do is with manual benders, the bending procedures taught in this section are made with those types of tools. There are basically two types of manual benders used for bending rigid metal conduit and EMT. They are rigid benders, called the hickey, and the one-shot bender. The one-shot bender normally is made for EMT, but some are made to be used for both EMT and rigid. The one-shot bender is so called because a full 90° bend can be made with a single motion. Conduit sizes up to 1-inch rigid or 1-inch EMT can be bent without much trouble using manual benders. Larger sizes are usually bent with power benders.

    - Conduit installations are normally referred to as runs of conduit. A run of conduit is the conduit, fittings, straps, conductors, and bends needed from one opening to the next; for example, from the panelboard to the first outlet or from the first outlet to the second outlet. In a run of conduit, or from the first outlet to the second outlet, there cannot be more than the equivalent of four 90° bends, for a total of 360°. This includes the bends located at the box or opening. The purpose of allowing only so many bends in a run of conduit is to help in pulling conductors into the conduit. Experience has taught us that if more than 360° of bends are used, it is very difficult to pull conductors through the bends. By using a conduit body in a run, you provide an opening for pulling the conductors without having to mount a box. At the same time, you can make a turn around or go over an obstacle and maintain a neat conduit installation.

To perform these tasks, follow these steps:

Right-angle bend

- One of the most common bends you'll make in the field is the right-angle bend, more commonly called a quarter bend, a 90° bend, or just a 90°. It can be used for going around an inside corner, into the top or bottom of a box from a horizontal run, or for just going over an object.

- Anyone can make a 90° bend in a stick of conduit and then cut it off to make it fit the situation, but this practice wastes time and material. The secret is to find out where the bend is needed, mark the conduit accordingly, and make the bend in the right place. This practice will save time and material. Before you can determine where to place your bender on the pipe, there are some things you must know. First, the distance from the end of the conduit to the back of the 90° bend is called the stub length or simply the stub (See figure 1). Second, the radius of the bend takes up a part of the stub. This part of the stub is called take-up, and is shown in figure 1. The amount of the take-up depends on the type and size of the conduit you are bending (See figure 2).

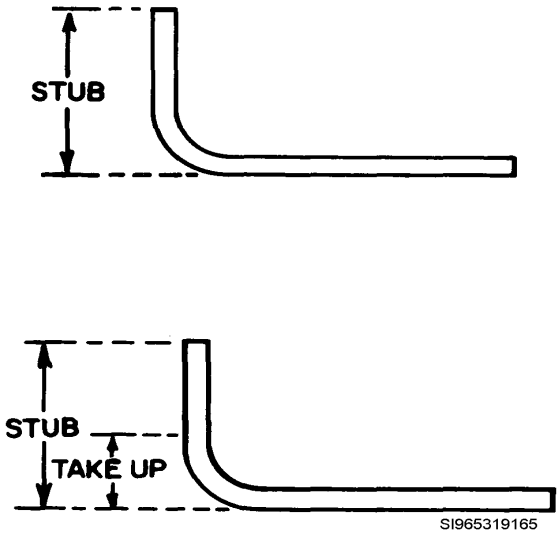


Figure 1. Conduit take-up and stub

Now let's see how a 90° bend is made to fit a specific situation. Suppose the conduit is to be run from the top of a panel to the ceiling and then run horizontally along the ceiling. The conduit is to be 1/2-inch EMT and a one-shot bender is to be used.

Step 1: 90 degree bend.
Measure from the top of the panel to the ceiling. This gives you the stub length. Assume this length is 18 inches. Measure 18 inches from the end of the conduit and make a mark at this point as shown in figure 1. Next, look at figure 2 to find the take-up inches back toward the end of the conduit from your
first mark and make a second mark.

TABLE 6-1
CONDUIT TAKEUP
Amount of Take Up
For 90° Bends
(One-shot Benders)

Size and Type of Conduit	Take Up
1/2" EMT	5"
3/4" EMT or 1/2" Rigid*	6"
1" EMT or 3/4" Rigid*	8"
1 1/4" EMT or 1" Rigid*	11"
*IMC and Rigid will be the same	

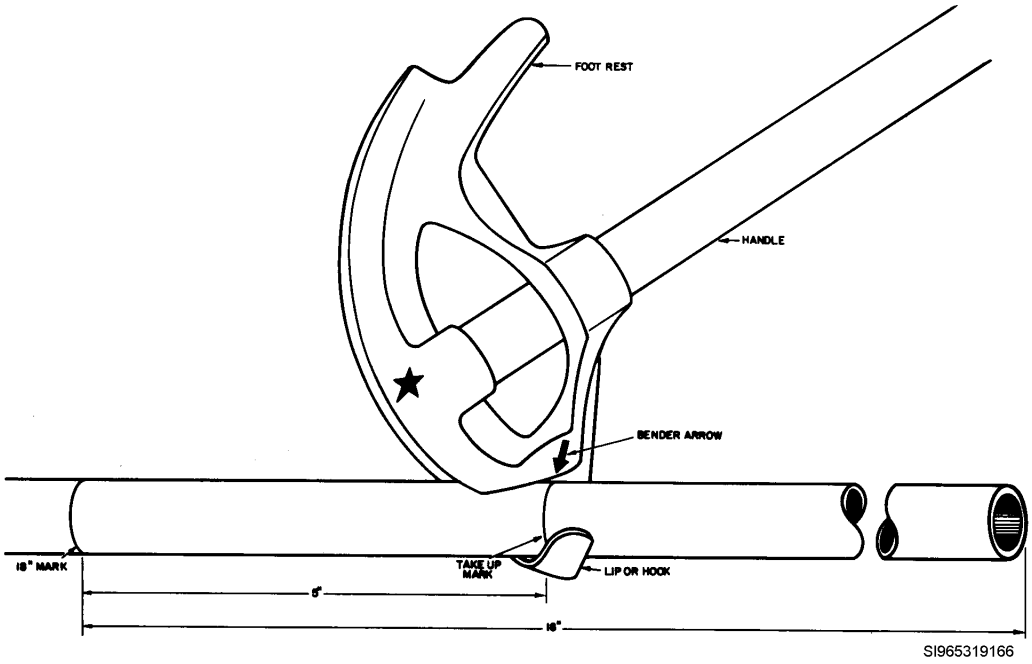


Figure 2. Alignment of arrow and take-up mark for bending 90 degrees.

- Now place the conduit on the floor and straddle it so that the stub is in front of you. Hold the bender in one hand with the lip on the floor pointed toward the stub end. Use the other hand to place the conduit in the bender. Align the bender arrow with the take-up mark. Put one foot on the footrest and hold the handle with both hands.
- To make the bend, apply pressure on the footrest as you pull on the handle until the handle is at about a 30° angle with the floor, as shown in figure 3. You should now have a 90° bend with an 18-inch stub.

- To check and see whether the bend will fit properly, you can place it next to anything that you know is a right angle and measure from the floor to the end of the stub. If the bend is not a full 90°, you can place the bender back on the conduit as described before and pull more bend. If it is more than a 90°, you can place the handle of the bender over the end of the stub and with one foot on the conduit on the floor, spring the stub back.

- **NOTE: Right-angle bends should always be made with the conduit and the bender on the floor.**

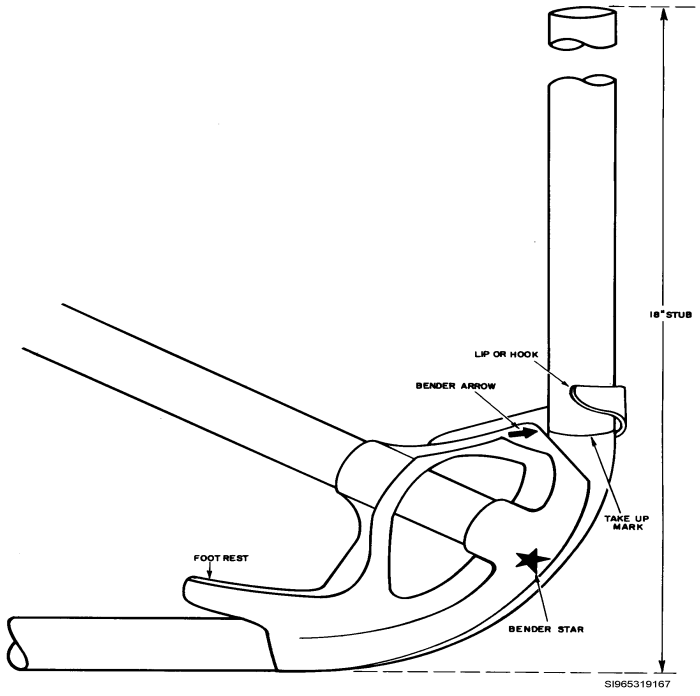


Figure 3. Right angle bend, 90 degrees.

Step 2: Back-to-back bend

- The back-to-back bend is actually two adjacent 90° bends made in the same piece of conduit. You make the first 90° bend with a certain amount of stub, as described previously. To determine where to place the bender for the second bend, you must first have an outside-to-outside measurement. This measurement is the distance from the back of the first bend to where you want the back of the second bend. You must then transfer this measurement to the conduit and make a mark. There are two methods to make the second bend. The first is to subtract the take-up, use the arrow on the bender, and pull the bend in the same direction as you did the first bend. The second method, and probably the easiest, is to turn the bender around, line up the star on the bender with your outside-to-outside measurement, and pull the bend in the opposite direction as shown in figure 4.

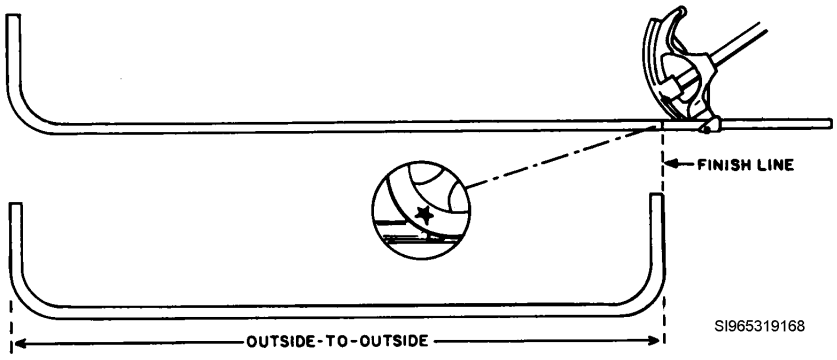


Figure 4. Using the star for back-to-back bend.

Step 3: Offset bend

- An offset bend is two equal bends in opposite directions. Use it to avoid contacting a part of the structure or to bring the conduit out from the structure to match a knockout in a box or panel. Figure 5 shows an offset into a utility box. The angle of the bends in an offset depends on several things: how much offset is needed, how much room there is where the offset is going to be placed, and the type of obstacle you are avoiding. The offset shown is usually about 1 inch in depth and the bends are about 10° angles. There is no way to mark the conduit for a box offset of this depth. The amount of bend and the distance between them are estimated. The key to making a good box offset is practice. Notice that after the bends are made, the conduit sections on each end of the offset are parallel to each other.

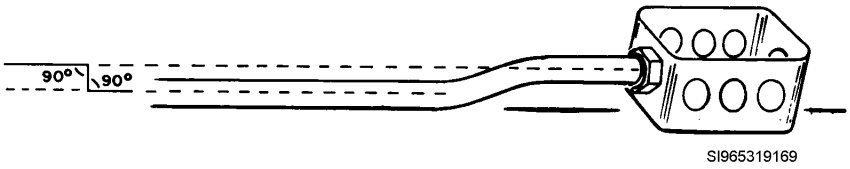


Figure 5. Box offset

- To make accurate offsets of 2 inches or more in depth, a predetermined distance can be marked on the conduit. The distance between the bends depends on the depth of the offset and the amount of bend that you are going to use. Figure 6 shows the formula you should use to find the distance to be marked on the conduit. It also shows the constant multiplier that must be used in the formula for the angle of bends you intend to use. Let's use an example to see how the formula works. Suppose you need to avoid a part of a structure that requires a 3-inch offset and you are going to use 30° bends.

- Figure 6 shows that the constant multiplier for 30-inch bends is two. Using the formula, multiply the depth of the offset (3 inches), times the constant multiplier (2 inches), and the result is the distance needed between the bends (6 inches). You place the marks for the bends 6 inches apart and, using the arrow of the bender, make a 30° bend on the same side of each mark, as shown in figure 6. In this example, a 30° bend gives us the offset we need. If you make both bends inside the marks, you'll end up with much less than the desired offset. If you make both bends outside the marks, you'll have too much offset. The amount of bend, in this case 30° at each mark, is obtained by using the degree markings on the bender. Notice that the side of the conduit closest to the bender is in line with the 30° marking on the bender, as shown in figure 7. If you have a bender without markings, you can make a layout of a 30° angle on a large piece of paper or on the floor with chalk. Then check the bend against the 30° angle of the layout. Normally, offsets are made by making the first bend on the floor and the second bend in the air.

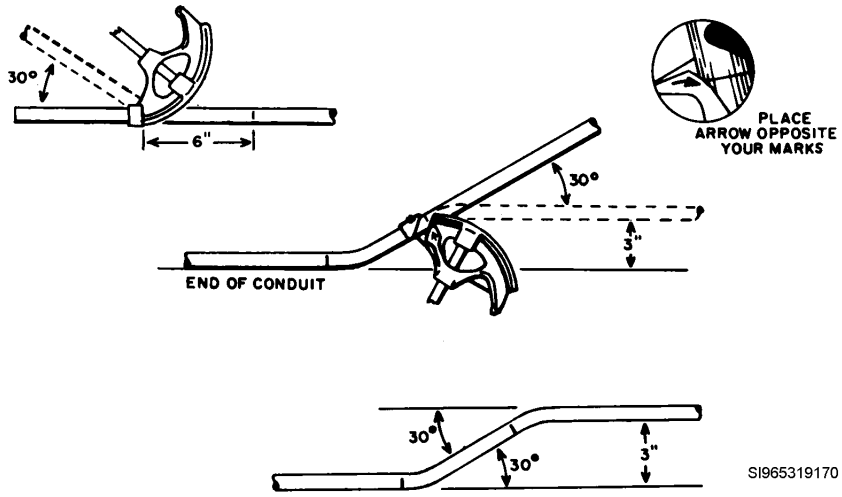


Figure 6. Bending an offset

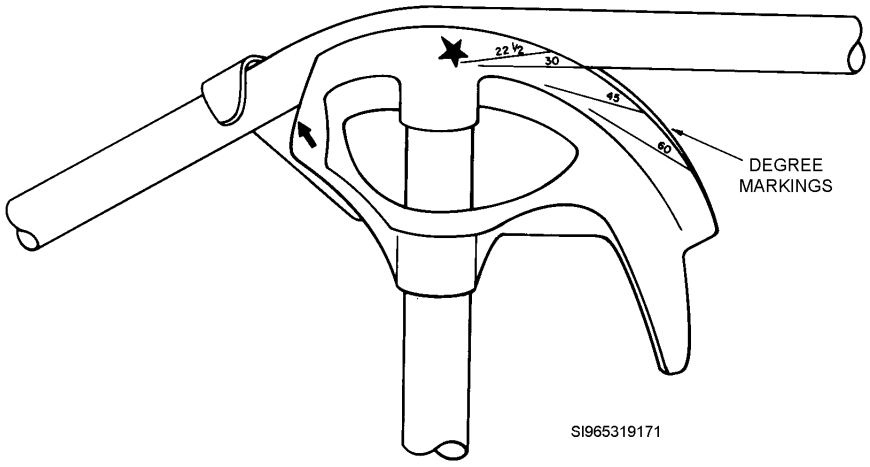


Figure 7. Bender degree markings.

Use hickey bender.

- The procedures for making the different types of bends discussed thus far have all been with a one-shot bender. The same bends can be made with a hickey bender, although the procedures are slightly different. For instance, to make a 90° bend in 1/2-inch rigid metal conduit, you must use the steps in figure 8. Let's say you need a 20-inch stub at the end of the 1/2-inch stick of rigid. The steps for bending with a hickey are as follows:

Step 1: Mark off 20 inches from the end of the conduit.

Step 2: Determine the take-up for 1/2-inch rigid.

Step 3: Make a second mark 6 inches back toward the end of the conduit.

Step 4: Place the hickey at the second mark and pull about a 30° bend.

Step 5: Move the bender towards the 20-inch mark about 2 inches. Pull another 30° bend.

Step 6: Move the bender to where the heel of the bender is on the 20-inch mark and complete the 90° bend.

- Since the hickey bender does not usually have degree markings on it, you must estimate the amount of bend you are making with each bite. Small bites reduce the possibility of crimping or kinking the conduit. Bending conduit is an art. Like all forms of art, the more often it is done correctly, the better the artist becomes.

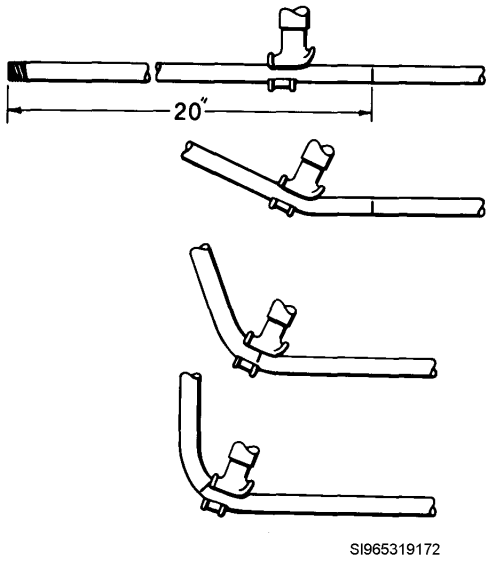


Figure 8. bending a 90 degree with a hickey.

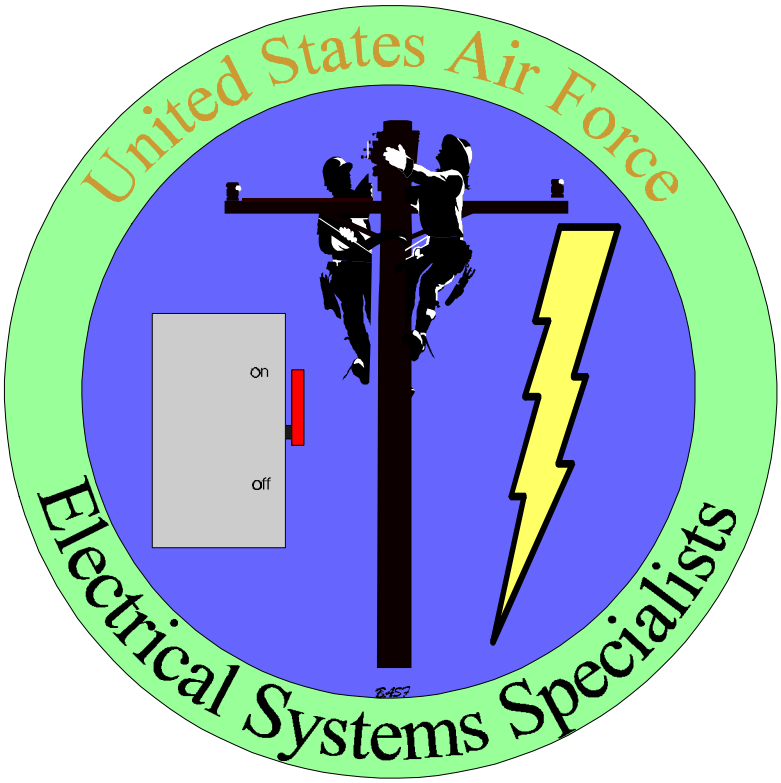
Review Questions
For
Using Manual Conduit Benders

Question	Answer
1. How should you make bends in conduit?	a. Not to exceed 30 degrees in one bend. b. Forming it to the mounting surface while holding in location. c. Not less than 90 degrees in one bend. d. Without reducing the inside diameter of the conduit at the bend.
2. What are the two most common manual benders?	a. Hickey and one shot. b. Power and hydraulic. c. Rigid and soft. d. One way and two way.
3. Which manual bender makes a full 90 degree bend in one motion?	a. Power b. One shot c. Hickey d. One way
4. What makes up a run of conduit?	a. The conduit, fittings, straps, conductors, and bends used from one bend to the next. b. One full length of conduit. c. The conduit, fittings, straps, conductors, and bends used from one opening to the next. d. The conduit, fittings, straps, and bends used from one opening to the next.
5. How many degrees of bends can be made in a single run of conduit?	a. The equivalent of 4 quarter bends or 360 degrees. b. The equivalent of 2 quarter bends or 180 degrees. c. The equivalent of 2 half bends or 360 degrees. d. the equivalent of 1 half bend or 180 degrees.

USE MANUAL CONDUIT BENDERS

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee identify the different type of conduit that can be manually bent?		
2. Can trainee identify the type of manual benders and their different uses?		
3. Can trainee identify the types of manual bends?		
4. Can trainee make each type bend with appropriate type of bender on the appropriate type conduit?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



TOOLS AND EQUIPMENT

MODULE 24 AFQTP UNIT 14

USE MANUAL CONDUIT THREADERS (24.14.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

USE MANUAL CONDUIT THREADERS

Task Training Guide

STS Reference Number/Title:	24.12. – Tools and equipment, use manual conduit threaders
Training References:	• CDC 3E051A, vol. 4 • AFI 32-1064, Electrical Safe Practices
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Pipe threader tool • Vise • Rigid pipe • Leather gloves • Cutting oil
Learning Objective:	• Given equipment, use manual conduit threader
Samples of Behavior:	• Following approved steps, correctly operate manual conduit threader • Know safety requirements for operating line maintenance controls
Notes:	
• Any safety violation is an automatic failure.	

USE MANUAL CONDUIT THREADERS

Background: Once rigid metal conduit or intermediate metal conduit is cut, it must be threaded for use with threaded couplings, locknuts, and bushings. When threading conduit, use a standard conduit-cutting die with a 3/4-inch taper per foot. This die cuts a deeper thread on the end of the conduit and then tapers the cut at the rear or shoulder of the thread. This is just the opposite of a running thread on a bolt. (See figure 1.) You can see both conduits are wrench-tight in the coupling but thread is showing on the outsides. The dies used for threading smaller sizes of conduit are usually hand driven. The handle may be solidly attached to the die, or the die assembly may be of the ratchet type. For larger sizes, or when large installations are made that require considerable conduit threading, a motor-driven, pipe-threading machine is recommended.

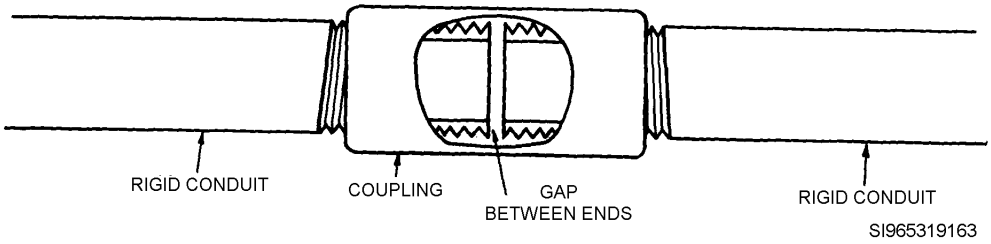


Figure 1. Conduit threads in a coupling.

To perform these tasks, follow these steps:

Step 1: Inspect dies.

- The most common rigid conduit threader uses nonadjustable ratchet dies (fig. 2), which come in sizes to fit conduit from 1/2 inch to 2 inches. Before threading the pipe, inspect the dies to see that they are sharp and free from nicks and wear.

Step 2: Cut threads.

- Next, insert the pipe into a vise, place the guide end of the pipe threader on the pipe, and push the threading dies against the pipe with the heel of your hand. With pressure against the threader, take three or four short clockwise strokes downward to start the threads. Continue the threading with clockwise strokes mixed with a reverse stroke every now and then until two or three threads extend beyond the die. To reverse the threader, you must pull the ratchet lock out and turn it a half turn. The reverse turns keep the threads and dies clean and free of bits of metal. Cutting oil applied during the threading helps the cutting process by reducing friction.

Step 3: Remove threader.

- To remove the threader, release the ratchet lock and turn the die by hand counterclockwise. Removal of the die also cleans the threads.

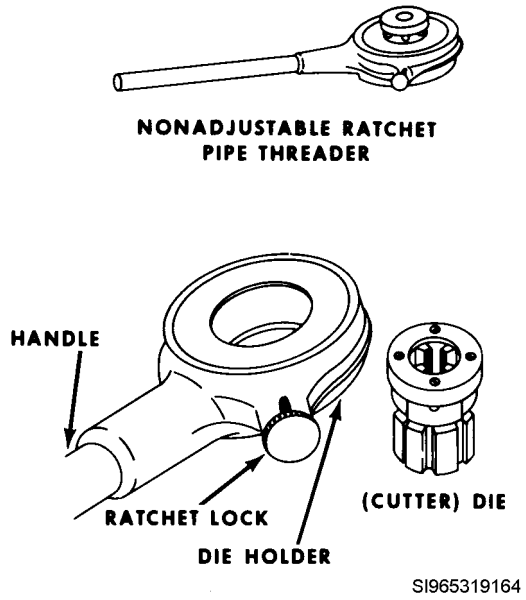


Figure 2. Ratchet threader and dies.

NOTE: It is important that the right amount of threads be cut for the job. In other words, a full thread must be cut so that the ends of the conduit will come together in a coupling, as shown in figure 1. Full threads are also necessary for the conduit to make a firm seat in the shoulder of a threaded hub of a conduit fitting. If too many threads are cut, the conduit will fit too loosely in the coupling or hub. The procedure described previously for cutting threads until two or three threads extend beyond the die will usually give you a full thread.

Review Questions
For
Using Manual Conduit Threaders

Question	Answer
1. What two types of conduit must be threaded for use with threaded couplings, locknuts, and bushings?	a. Rigid and intermediate metal conduit. b. Flex and EMT. c. Soft wall and Rigid. d. EMT and flex.
2. What type of cutting die must be used to thread conduit?	a. Fine conduit-cutting die with a ¾-inch taper per foot. b. Course conduit-cutting die with a ¾-inch taper per foot. c. Course conduit-cutting die with a ½-inch taper per foot. d. Standard conduit-cutting die with a ¾ - inch taper per foot.
3. What is the purpose of reverse strokes during the threading procedure?	a. Makes cutting the threads easier. b. Keeps the dies sharp. c. Reverse strokes keep the threads and dies clean. d. Too remove the threading tool.

USE MANUAL CONDUIT THREADERS

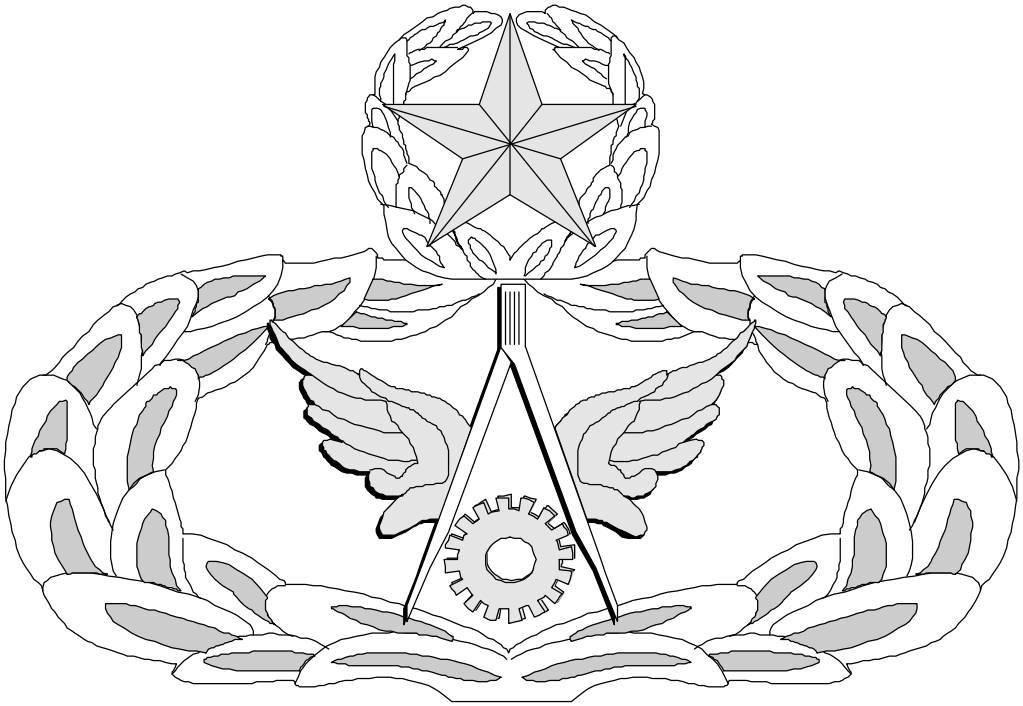
Performance Checklist		
Step	**Yes**	**No**
1. Can trainee identify purposes for manual conduit threading?		
2. Can trainee properly inspect dies?		
3. Can trainee properly and safely cut threads on conduit to include a full thread?		
4. Can trainee properly remove threader from conduit?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



For

ELECTRICAL SYSTEMS

(3E0X1)

MODULE 24

TOOLS AND EQUIPMENT

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

HOTLINE TOOLS

(3E0X1-24.1.1.)

Question	Answer
1. The purpose of using hotline tools is to minimize the number of power interruptions or outages.	a. True
2. Where should hotline tools be stored?	a. In bins or on racks
3. Silicone cloths are not used to protect the glossy finish of fiberglass hotsticks because they _____.	b. Hamper the refinishing process
4. How often are hot line tools tested electrically?	c. Every 6 months
5. How often do hot sticks require a moisture test?	c. Every 6 months

RUBBER PROTECTIVE EQUIPMENT

(3E0X1-24.1.2.)

Question	Answer
1. Which type of manufactured rubber protective equipment is subject to ozone and corona deterioration?	a. Type I natural or polyisoprene synthetic rubber
2. In which ANSI/ASTM specification would you find the in-service inspection requirements for rubber insulating gloves?	a. D120
3. What problem would you most likely encounter with rubber gloves that are a little too big for your hands?	a. Loss of dexterity
4. How are rubber sleeves worn in conjunction with rubber gloves?	a. Rubber sleeves are tucked into gloves
5. How often must rubber gloves be field air-tested?	a. Before each use and more often if problem is suspected
6. How are rubber sleeves stored?	a. Both B and C
7. What are the items to look for in inspecting a rubber sleeve?	a. All of the above
8. When locating defects in blankets, roll them twice on each side so that the second roll is at a 60 degree angle to the first.	a. False
9. What must be done if you find a petroleum product on a rubber blanket?	a. Wipe of immediately

CLIMBING EQUIPMENT

(3E0X1-24.1.7.)

Question	Answer
1. How often should body belts and safety straps be cleaned and dressed?	c. Every three months
2. What is the suggested length of time between oiling body belts and safety straps?	b. 6 months
3. Which of the following IS NOT an advantage that belts made of webbing have over leather?	a. Flexibility
4. What items are checked while inspecting climbers?	d. All of the above
5. What is the average life of a set of climbers?	c. 5 years
6. What two tools do you need to field sharpen gaffs that aren't machine sharpened?	d. A and C
7. Rocking motions are avoided while sharpening gaffs to prevent rounding the edges of the gaff.	a. True

USE ELECTRICIAN'S HANDTOOLS

(3E0X1-24.2.)

Question	Answer
1. Never use a screwdriver as a chisel or prybar.	a. True
2. Which type pliers would be used to cut larger types of wire?	c. Sidecutters
3. A flexible hacksaw blade with 24 teeth or more would be best for cutting electrical metallic tubing.	a. True
4. The drivebolt for the ½ inch conduit punch requires what size hole?	b. 3/8 inch hole
5. Which tool should you use to turn the drivebolt to punch a hole?	b. Wrench
6. The hole you punch will have smoother edges if you give the punch time to cut.	a. True
7. Which tool would you use to remove a coupling from a piece of 2 inch rigid conduit?	c. Pipe wrench
8. If space is not a problem, which tool would you use to tighten a nut onto a bolt?	b. Box end wrench
9. A box end wrench can only be used on hexagon nuts and boltheads.	b. False
10. Which one of the four statements is false.	b. Pliers can sometime be used as hammer
11. As a general rule, which of the following statements would be true.	d. All of the above

USE PORTABLE POWER TOOLS

(3E0X1-24.3.)

Question	Answer
1. Size of the drill is determined by the largest drill bit shank that will go in the jaws of the drill.	a. True
2. A spade bit is used for drilling what type material?	b. Wood
3. A masonry bit is used *for drilling* what type of material?	d. All of the above
4. The electric hand drill is made of heavier construction than the rotary hammer.	b. False
5. The rotary hammer drills and hammers simultaneously.	a. True
6. Which saw would be best for cutting an opening in a finished wall?	c. Saber saw
7. Ventilation holes must be kept clean to prevent power tools from overheating.	a. True
8. Tight even pressure is all you need to operate most portable power tools.	a. True
9. Apply too much pressure arid the portable power tool will stall or overheat.	a. True
10. Always make sure there is nothing in the wall before drilling or cutting.	a. True
11. When using a rotary hammer you may need to use a mask to protect your nose and throat from dust.	a. True

MULTIMETER

(3E0X1-24.5.1.)

Questions and answers are contained in AFQTP CD-ROM 3E0X2 “Power Production Test Equipment”.

1.	a.
2.	a.
3.	
4.	
5.	
6.	
7.	
8.	
9.	

CLAMP-ON AMMETER

(3E0X1-24.5.2.)

Questions and answers are contained in AFQTP CD-ROM 3E0X2 “Power Production Test Equipment”.

1.	
2.	
3.	a.
4.	d.

PHASE ROTATION METER

(3E0X1-24.5.3.)

Questions and answers are contained in AFQTP CD-ROM 3E0X2 "Power Production Test Equipment".

MEGOHMMETER

(3E0X1-24.5.4.)

Questions and answers are contained in AFQTP CD-ROM 3E0X2 "Power Production Test Equipment".

HIGH VOLTAGE PHASE TESTER

(3E0X1-24.5.14.)

Question	Answer
1. The basic instrument can test voltages up to?	d. 16 kV
2. When using a second pair of resistor sticks, you multiply the meter reading by?	b. 5
3. Why is the handle on which the meter is mounted placed on the ground potential contact?	a. To reduce stray capacitance that may influence reading.
4. Why must you not use probes on live front underground rural distribution equipment?	d. Working in close proximity of energized parts and grounded surfaces
5. What should you do if you notice frayed insulation on the test cable?	d. Do not use and immediately inform supervisor

EARTH RESISTANCE TESTER

(3E0X1-24.5.16.)

Question	Answer
1. The purpose of the Vibroground is to gather ground resistance readings from installed grounds?	a. True

Question	Answer
2. Unlike the separate voltmeter, ammeter method, this instrument provides a readout directly in volts.	b. False
3. If you are unable to balance galvanometer on any range, what would be the problem?	d. both b & c
4. Which electrode is connected to C1 on the Vibroground.	b. Current

PERFORM OPERATOR'S MAINTENANCE ON HIGH REACH TRUCK WITH INSULATED BUCKET

(3E0X1-24.6.)

Question	Answer
1. What AF Form is used to annotate discrepancies found on the high reach truck?	c. 1806
2. The three operational checks made on the high reach truck are Pre-operational, Operational, Post-Operational.	b. False
3. What operational check is made while the vehicle or auxiliary equipment is in use?	b. Operational
4. What check lets the operator identify any damage that may have been overlooked during the day's work?	c. Post-operational
5. Which of the following problems CAN NOT arise from low tire pressure?	c. Broken valve stems
6. How often is tire pressure checked and where is it annotated?	d. Monthly / 1806

PERFORM OPERATOR'S MAINTENANCE ON LINE MAINTENANCE TRUCK

(3E0X1-24.7.)

Question	Answer
1. What AF Form is used to annotate discrepancies found on the line maintenance truck?	c. 1806
2. The three operational checks made on the line maintenance truck are Pre-operational, Operational, Post operational.	a. True
3. What operational check is made while the vehicle or auxiliary equipment is in use?	b. Operational
4. What check lets the operator identify any damage that may have been overlooked during the day's work?	c. Post-operational
5. Which of the following problems CAN arise from low tire pressure?	d. A and B
6. How often is tire pressure checked and where is it annotated?	b. Monthly / 1806
7. Whose responsibility is it to maintain line truck fluid levels?	c. Operator

OPERATE HIGH REACH CONTROLS

(3E0X1-24.8.)

Question	Answer
1. How many people make up an aerial crew?	b. At least 2 qualified workers
2. The operator must make sure no one is close enough to the truck to get hurt when _____.	c. Lowering the stabilizers
3. What safety equipment must be worn when working on or around a bucket truck?	c. both a & b
4. When working aloft the bucket should be positioned _____ or to the _____ and must not contact any installed equipment.	c. Under/ Side
5. The worker must use any means necessary to reach work positions, even if it includes standing on top of the bucket or on planks across the top of the bucket.	b. False

OPERATE LINE MAINTENANCE TRUCK CONTROLS

(3E0X1-24.9.)

Question	Answer
1. What size winch cable will handle loads of less than 10,00 pounds?	a. 1/2 inch wire rope
2. What is the advantage of using fabric winch cable instead of a wire rope cable?	d. No steel strands to cut the skin
3. What can you do if the line truck must be set up on hot asphalt or soft ground?	c. Place planks under jack pads
4. What piece of equipment is used to pull a pole?	d. Pole jacks
5. How do you compensate for various loads while using capstan?	d. All of the above

USE MANUAL CONDUIT BENDERS

(3E0X1-24.12.)

Question	Answer
1. How should you make bends in conduit?	d. Without reducing the inside diameter of the conduit at the bend.
2. What are the two most common manual benders?	a. Hickey and One shot.
3. Which manual bender makes a full 90 degree bend in one motion?	b. One Shot.
4. What makes up a run of conduit?	c. The conduit, fittings, straps, conductors, and bends used from one opening to the next.
5. How many degrees of bends can be made in a single run of conduit?	a. The equivalent of 4 quarter bends or 360 degrees.

USE MANUAL CONDUIT THREADERS

(3E0X1-24.14.)

Question	Answer
1. What two types of conduit must be threaded for use with threaded couplings, locknuts, and bushings?	a. Rigid and intermediate metal conduit.
2. What type of cutting die must be used to thread conduit?	d. Standard conduit-cutting die with a ¾-inch taper per foot.
3. What is the purpose of the reverse strokes during the threading procedure?	c. Reverse strokes keep the threads and dies clean.