DOCUMENT RESUME

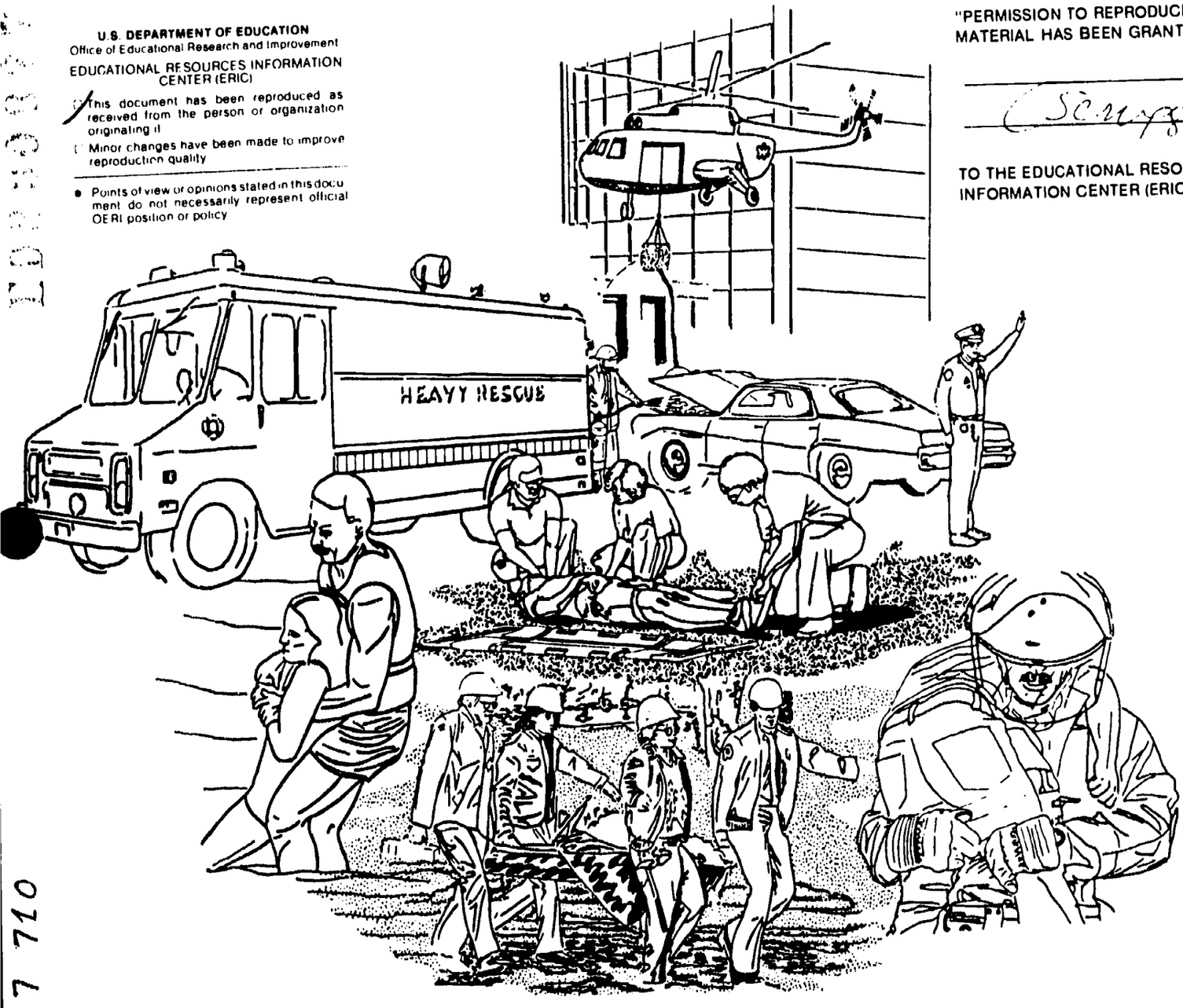
ED 330 877 CE 057 710

TITLE	Rescue Manual. Module 3.
INSTITUTION	Ohio State Univ., Columbus. Instructional Materials Lab.
PUB DATE	89
NOTE	39p.; For related modules, see CE 057 708-717. Photographs may not reproduce well.
AVAILABLE FROM	Instructional Materials Laboratory, Ohio State University, 842 West Goodale Blvd., Columbus, OH 43212 ($4.25; set of 10, $33.00).
PUB TYPE	Guides - Classroom Use - Instructional Materials (For Learner) (051)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Accidents; *Electricity; *Emergency Programs; *Emergency Squad Personnel; First Aid; Learning Modules; Occupational Safety and Health; Postsecondary Education; *Rescue; Safety; Safety Education

ABSTRACT

This learner manual for rescuers covers the current techniques or practices required in the rescue service. The third of 10 modules contains 4 chapters: (1) forcible entry; (2) structure search and rescue; (3) rescue operations involving electricity; and (4) cutting torches. Key points, an introduction, and conclusion accompany substantive material in each chapter. (NLA)

RESCUE MANUAL



MODULE 3

Forcible Entry
Structure Search and Rescue

Rescue Operations Involving Electricity
Cutting Torches

INSTRUCTIONAL MATERIALS LABORATORY
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

Edited and distributed by the
Instructional Materials Laboratory
The Ohio State University
College of Education
Columbus, Ohio 43210

Rescue operations may subject both rescuer and victim to the possibility of injury or death. Rescuers must understand the nature and effect of each rescue technique, and practice techniques regularly, using this text to enhance their learning. The materials and information presented here are intended only as a learning aid, and are no substitute for training. Expert opinions, recommendations, and guidelines change as research and experience refine procedures. This text includes the most up-to-date information from rescuers working in the field.

Specialized procedures require demonstration and training by subject-matter experts. It is not likely that a rescuer will become proficient in all rescue operations. Most rescuers develop proficiency in only a few areas but may be familiar with several others.

This text suggests procedures and explains how to do them. The techniques given are guidelines only. Each department should incorporate its own procedures and address local needs.

RESCUE MANUAL

INSTRUCTIONAL MATERIALS LABORATORY
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

ACKNOWLEDGEMENT

Acknowledgment is extended to the following persons for their willingness to share their knowledge and expertise and for authoring information presented in this module:

Structure Search and Rescue
Gary Fellows, Fire Protection Engineer, Wheeling/Pittsburg Steel, Steubenvile, Ohio

Electricity
Louis Vargo, Fire Chief, Mt. Pleasant Fire Department, Mt. Pleasant, Ohio

Cutting Torches
Greg Lash, Columbus Division of Fire, Columbus, Ohio

FOREWORD

The intent of this manual for rescuers is to provide the latest instructional content and serve as an up-to-date, comprehensive source of information covering the current techniques or practices required in the rescue service. To help in this endeavor, an instructor's manual has been developed to be used in conjunction with this learner's manual. The manual has been produced in a series of modules to facilitate future revisions more rapidly and cost effectively.

The instructor's manual follows the key points identified in the text. Chapters have been included in the text which exceed those printed in any other resource. These include managing and operating the emergency vehicle, rope rescue techniques, industrial rescue, farm accident rescue, and various water emergency procedures, among others.

That the rescue profession is a dangerous and challenging career is a recognized fact. It is our hope that this text will help the rescuer meet the challenges of the rescue service in a safe and professional manner.

Tom Hindes
Director
Instructional Materials Laboratory
College of Education
The Ohio State University

PREFACE

The Ohio State University Instructional Materials Laboratory has played a major role in the training of public safety personnel through the development of text materials for many years. Due to the advances in the rescue techniques, it became apparent that the existing text was obsolete. Upon the advice of many knowlegeable people in the rescue service, the Instructional Materials Laboratory initiated the development of a new text that would be easily updated, and address the needs of the rescuer. To this end, an editorial review board representing a broad spectrum of individuals in the various phases of the research profession was convened to determine what topics this text should address. The culmination of this effort is the Rescue Manual. It is hoped that this text will be useful to not only the new rescuer but will serve as a reference source for the experienced rescuer.

Joyce Leimbach
Curriculum Consultant
College of Education
The Ohio State University

Ronald Slane
Technical Consultant
College of Education
The Ohio State University

MODULE 3

TABLE OF CONTENTS

MODULE CONTENTS

The 1989 Rescue Manual has been grouped into ten modules in accordance with the recommendations from the Rescue Editorial Board.

Module 1
Introduction
Occupational Stresses in Rescue Operations
Size-up
Critique
Reporting and Recordkeeping
Tools and Equipment for Rescue Operations
Planning for Emergency Operations
Incident Command System
Dealing with Natural Disasters

Module 2
Patient Care and Handling Techniques
Rescue Carries and Drags
Emergency Vehicle Operation
Self-Contained Breathing Apparatus
Protective Clothing

Module 3
Forcible Entry
Structure Search and Rescue
Rescue Operations Involving Electricity
Cutting Torches

Module 4
Construction and Characteristics of Rescue Rope
Knots, Bends, and Hitches
Critical Angles
Belay Systems
Raising Systems
Rigging
Using the Brake-Bar Rack for Rope Rescue
Rope Rescue Techniques
Aerial Ladder and Aerial Platform Rescue

Module 5
Hazardous Materials

Module 6
Industrial Rescue
Rescue From a Confined Space
Extrication From Heavy Equipment
Rescue Operations Involving Elevators

Module 7
Extrication From Vehicles

Module 8
Trench Rescue
Shoring and Tunneling Techniques
Farm Accident Rescue
Wilderness Search and Rescue
Aircraft Rescue
Helicopter Information

Module 9
Ice Characteristics
River Characteristics and Tactics for Rescue
Water Rescue Techniques
Water Rescue/Recovery Operations
Dive Operations
Water Rescue Equipment
Water Rescue Safety Tips

Module 10
Glossary
Appendix

FORCIBLE ENTRY

KEY POINTS

- **The use of each type of manual forcible-entry tool**
- **Methods and procedures for properly cleaning, maintaining, and inspecting forcible-entry tools and equipment**
- **Materials and construction features of doors, windows, roofs, floors, and vertical barriers, and the dangers associated with each in an emergency situation**
- **Techniques for forcibly entering doors, windows, ceilings, roofs, floors, and vertical barriers**

INTRODUCTION

Rescuers must often gain entry to buildings to search for victims. The success of these operations depends on the rescuers' ability to quickly gain access to these buildings.

TOOLS

Axes

There are two basic types of axes used for rescue today, the flat head and the pick head axe (see Figures 1-A and 1-B). When carrying a pick head axe, it is important that the head of the axe be carried with the cutting edge pointing away from the body and the pick shielded with the hand (see Figure 2).

Since an axe becomes dulled quickly through use,

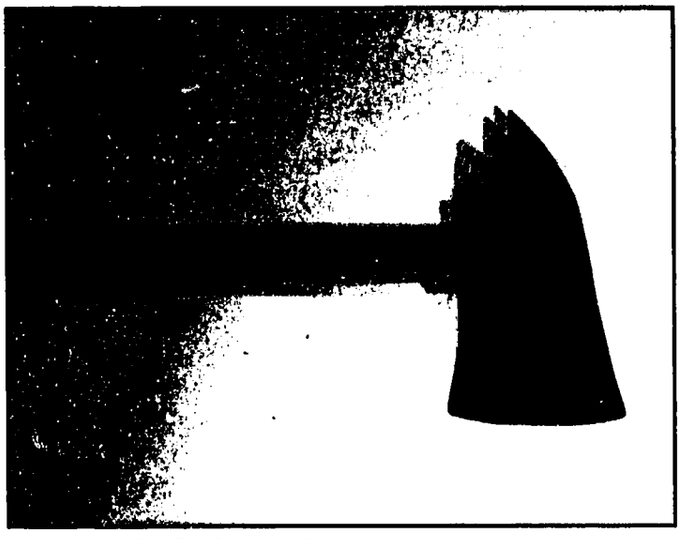


Figure 1-B. Pick Head Axe

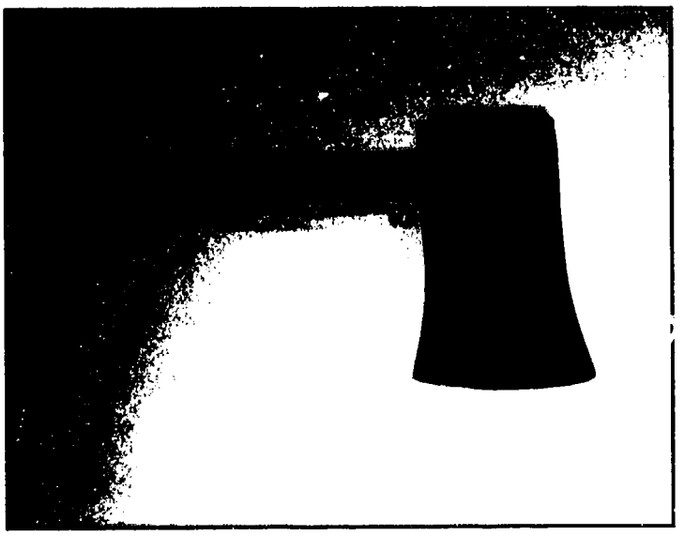


Figure 1-A. Flat Head Axe

Figure 2. Carrying a Pick Head Axe

a sharp edge is not necessary. Moreover the axe blade may be ground thin by sharpening, and a thin edge may break or chip easily and is a potential hazard. While newer axes have fiberglass handles, many axes have wooden handles. Wooden handles on axes and other tools should not be painted, because paint may camouflage hidden cracks in the wooden handles and create a hazard to the user. A coating of linseed oil should be applied to all wooden handles for protection and preservation.

Bolt Cutters

Bolt cutters are used to cut padlocks, bars, and hasps. A bolt cutter may also be used to help free trapped occupants from vehicles. It is important to remember that the case-hardened steel found in many locks cannot be cut with a bolt cutter (see Figure 3).

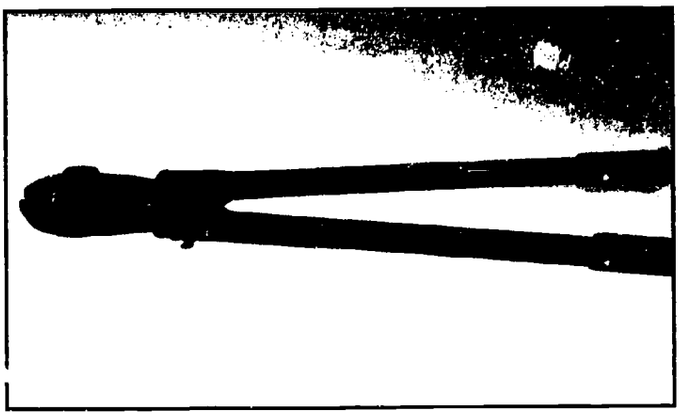


Figure 3. Bolt Cutter

Prying Tools

The tools commonly used for prying are the Halligan tool, claw tool, Kelly tool, pry axe, Hux bar, and the pry bar (see Figure 4). These tools may be used to force open locked doors and windows and pry materials apart. Some of these tools are designed to perform other jobs as well. One example of this is the Hux bar, which may also be used as a hydrant wrench.

Power Tools

With few exceptions, the power tools used for forcible entry are powered by either gasoline engines or electricity (see Figure 5). Other tools are run by hydraulic oil and compressed air (see Figure 6).

Battering Ram

This tool is used to breach brick walls and force doors that cannot be opened by any other means or that must be opened immediately. To breach a brick wall, a pickaxe must be used first to remove brick in an area approximately three feet from the ground. The battering ram is held by the handles by two persons on each side with the forked end toward

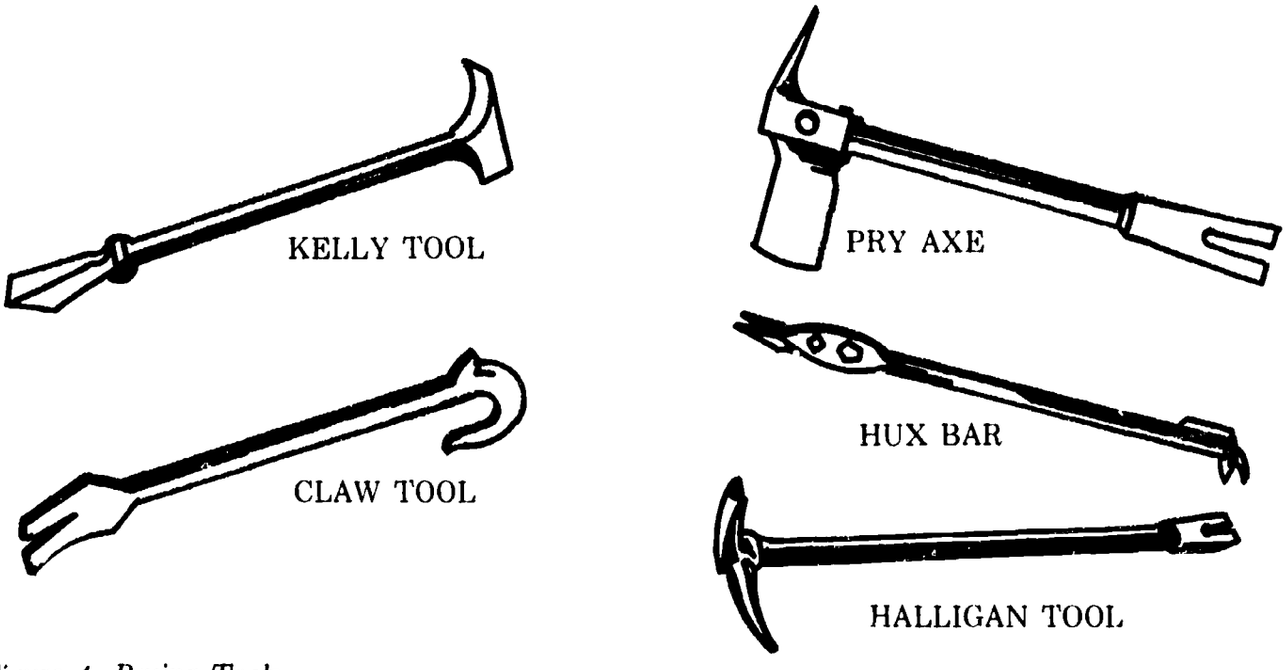


Figure 4. Prying Tools

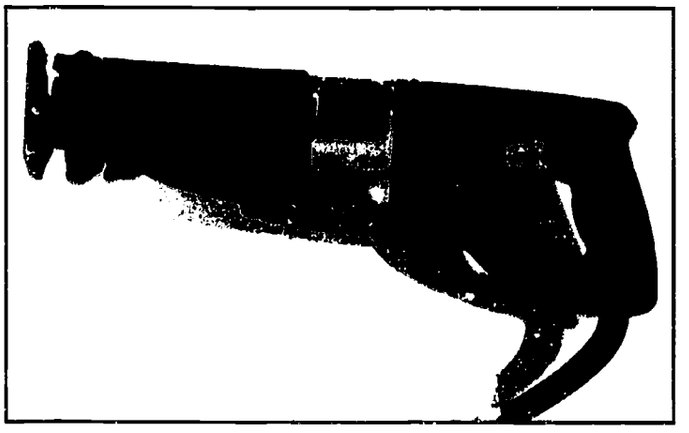


Figure 5. Electric Saw

Figure 6. Air Chisel

the wall, swung back at arm's length, then thrust against the wall with a slight lifting motion as it strikes the wall. If the battering ram is used to force a door, the blunt end (rather than the forked end) of the ram should strike the door beneath the lock (see Figure 7).

Lock Pullers

Lock pullers such as the K tool are designed to remove cylinder locks. In use, the K tool lock puller is driven onto the cylinder lock and then pried off with a Halligan or similar tool. The Kerry key is used to release the latch. A variety of tools are used by rescue personnel to gain entry into buildings, and rescuers should become familiar with all the tools used.

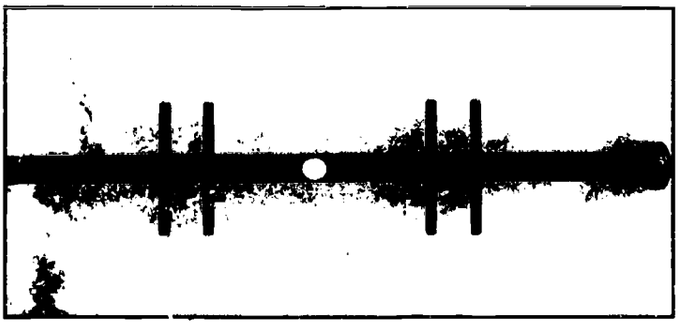


Figure 7. Battering Ram

PREPLANNING FOR ENTRY

In preparation for forcible entry, rescuers should determine which buildings in their area will probably need to be forced open. This preplanning should be accomplished before a rescue is needed. The following points should be considered:

- Which buildings are locked during part of the day, and when they are locked.
- Which buildings are always open at the street entrance, but have individual units that may require forced entry.
- Which buildings are locked at a street entrance and at an inner lobby door, both of which might have to be forced.
- Which buildings have doors that, when locked, can be easily forced open, and which have doors that are difficult to force. (For the latter, rescuers may be able to obtain keys to be carried on the apparatus.)
- Which buildings can be entered from the rear and sides, as well as the front. Normally, front entrances are the easiest to force, but the locations and construction of windows and doors at the sides and rear might allow them to be used most effectively for forced entry—especially if the front door is difficult to force.
- Which buildings have private security forces that will respond to an alarm with keys, thereby eliminating the need for forcible entry.
- Which buildings might present forcible entry problems as exposures, should a nearby or attached structure become involved with fire.
- Which is the best way to enter problem buildings by force if that should become necessary.

SIZE-UP

When rescue personnel arrive at the scene of an emergency, they must first determine if forcible entry is necessary to gain entry. Check all doors to see if they are locked before forcing a door. Remember,

no matter how proficient rescuers are at forcible entry, anything that must be forced will be damaged. It does not make sense to force a door when it is not locked or there is another door which is open. There have been occasions when this has been done.

Opening Windows

Because of the many different types of windows manufactured today, it would not be practical to include specifications regarding each type of window in this chapter. Only the most common windows will be discussed.

Double-Hung Windows

A double-hung window has a lock located where the upper and lower sash meet (see Figure 8). If the window is made of wood, this lock can often be forced out of the wood by using a prying tool in the middle of the bottom sash (see Figure 9). If the window is made of metal and glass, the glass will have to be broken and the lock released.

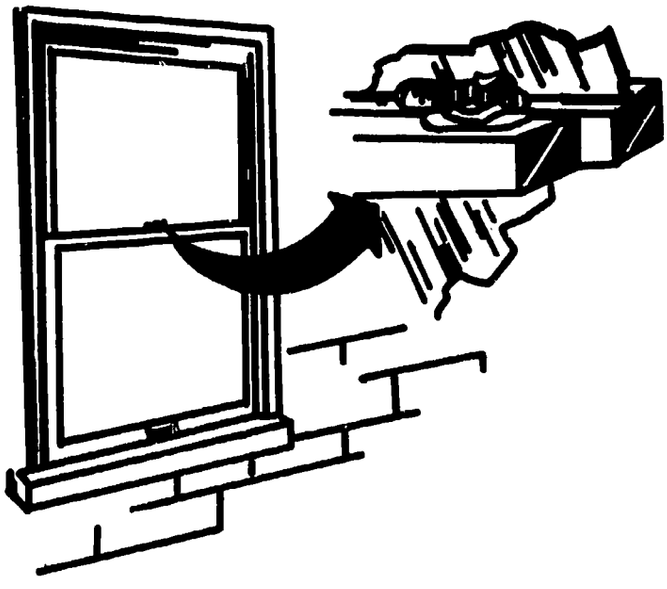


Figure 8. Checkrail (Double-Hung) Windows

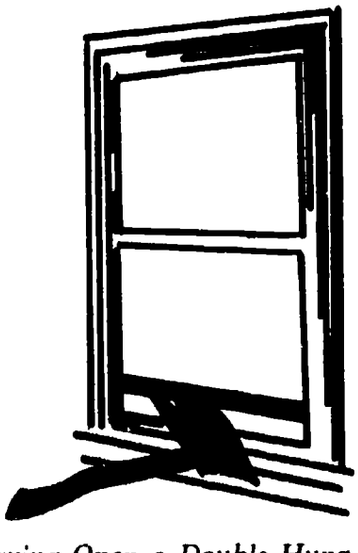


Figure 9. Prying Open a Double-Hung Window

Combination Storm Windows

A combination storm window is constructed so that the storm window and screen are stored in one unit. The storm window slides up for summer storage as the screen slides down. This process is reversed for winter storage. Some of these windows are constructed to provide for removal of storm windows and screens for cleaning. The problem rescuers encounter is that these windows and screens must be removed from the inside. Because the frames of these windows are made of aluminum, they will be damaged if forced. In many instances it is better to break the glass and/or remove the screen to gain entry.

Casement Windows

Casement windows are hinged on the sides and swing away from the structure as a crank is turned. They are locked by a latch that is found between the two windows. It is recommended that these windows be opened by removing the screen if necessary, breaking the glass on the side where the crank is located, reaching in and upward to release the latch, and then turning the crank to open.

Factory Windows

This style of window is constructed to open by swinging either outward or inward. Factory windows are made of metal with a latch-type lock (see Figures 10-A and 10-B). If the window contains more than one pane of glass, break the pane nearest the latch,

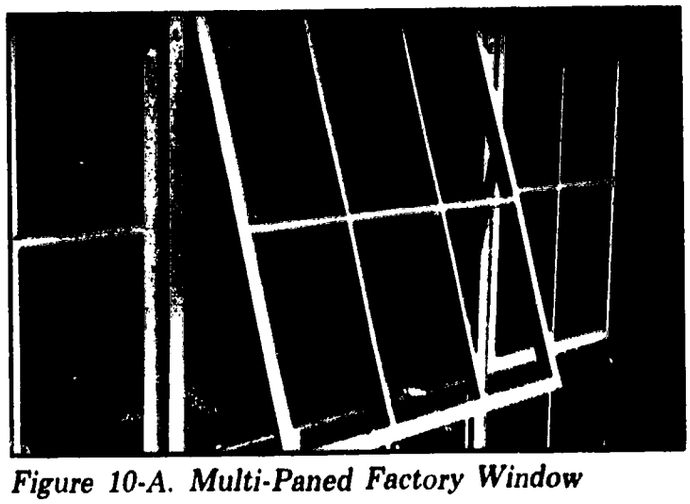


Figure 10-A. Multi-Paned Factory Window

Figure 10-B. Latch on Multi-Paned Factory Window

and swing the window either in or out. Some factory-style windows used in public buildings have only one large pane of glass; in this case break the glass, remove the rough pieces around the edge, and climb through the window (see Figures 11-A and 11-B).

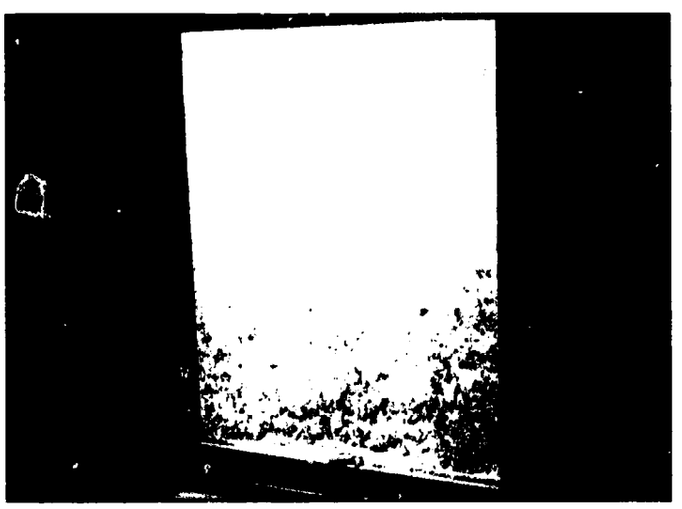


Figure 11-A. Single-Paned Factory Window

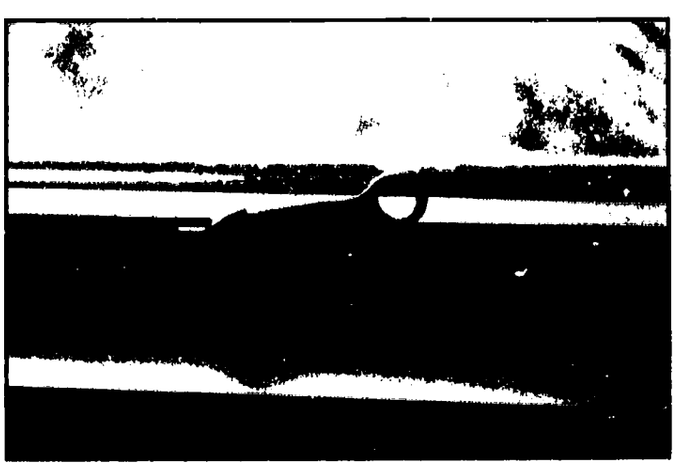


Figure 11-B. Latch on Single-Paned Factory Window

OPENING DOORS

Although it is easier to open a window than to force a door, there are buildings that do not have windows. In this situation the rescuer must force open the door to gain entry. **In all cases, try to open any door before forcing to see if it is in fact locked.** Many types of doors are used in building construction; only the most common will be considered in this chapter.

Residential Doors

All residential doors swing in and are either hollow-core or solid-core doors. A hollow-core door has several layers of plywood veneer glued over strips of wood or some other material such as corrugated cardboard to form a strong door. This type of door is usually found inside a house. The entrance doors are usually solid core doors. These doors are constructed of solid wood. They are much heavier than hollow core doors and considerably more expensive. Because opening a door that swings in is quite difficult, the following procedure is recommended.

If the door is in a stopped frame, the straight head of the Kelly tool may be inserted between the door and the jamb (see Figure 12). Then, by prying toward the door, the door may be sprung past the lock bolt.

If the door is in a rabbeted frame, there is little chance of springing the frame. The cross head of the Kelly tool may be inserted between the door and the jamb as shown in Figure 13. Prying against the door will break the door itself, the jamb, or the lock. If the door has glass in it, it is better to break the glass and manipulate the lock from the inside.

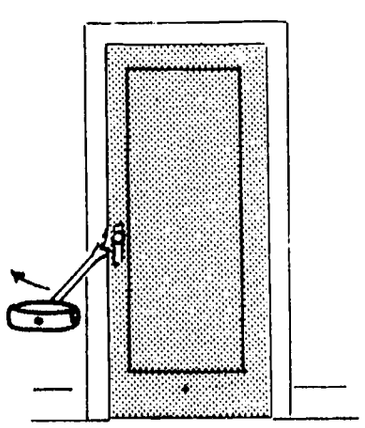


Figure 12. Kelly Tool Used on Door That Swings In

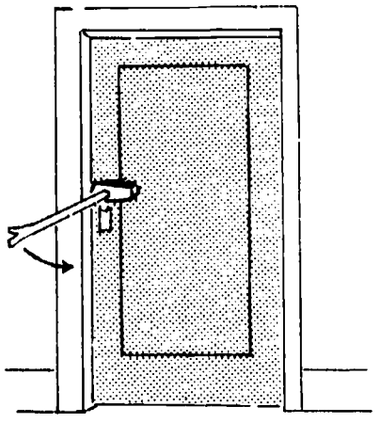


Figure 13. Kelly Tool Used on Rabbeted Jamb

To insure security, many people have installed more than one locking device on an entrance door. When this situation is encountered it may be easier to gain entry through a window. If no windows are available, the door may have to be destroyed to gain entry. Many entrance doors in homes have glass in the upper half. In this case, the glass may be broken to gain access to the lock.

Doors Found in Commercial Buildings

There are many types of doors used in commercial buildings. Through company inspections and pre-planning, the rescuer will become familiar with forcible entry requirements of special buildings.

Single-Hinged Door. All single-hinged doors in places of business should open outward. Single-hinged doors that open outward may be opened from the swing side with an axe, as shown in Figure 14. The

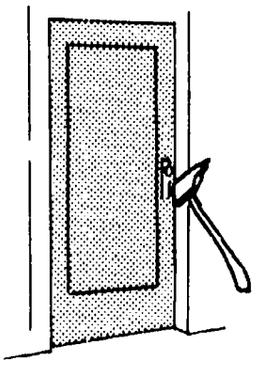


Figure 14. Opening Door With Axe

blade of the axe is inserted between the jamb and the door, just above or below the lock. Prying with the handle to one side away from the door, will usually spring the jamb enough to let the lock bolt pass under the keeper. The Kelly tool may also be used for this purpose (see Figure 15). The Buster

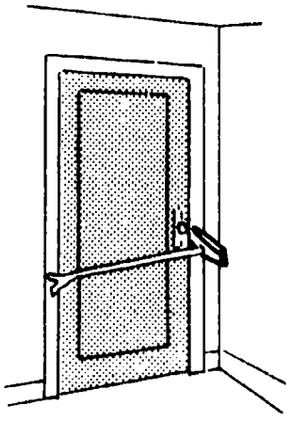


Figure 15. Opening Door With Kelly Tool

bar or Hux bar may be used for prying open a door in a manner similar to the Kelly tool. Either the straight or the cross head end of this tool may be used where a door is near a partition permitting better leverage with the tool.

Single-hinged doors on warehouses, stables, and other buildings may be locked with a hasp and padlock. If so, the staple of the hasp may be pried or twisted off with a tool such as shown in Figure 16. The point of the tool is inserted in the staple end. If a pry will not remove it, it may be twisted off, taking the lock with it.

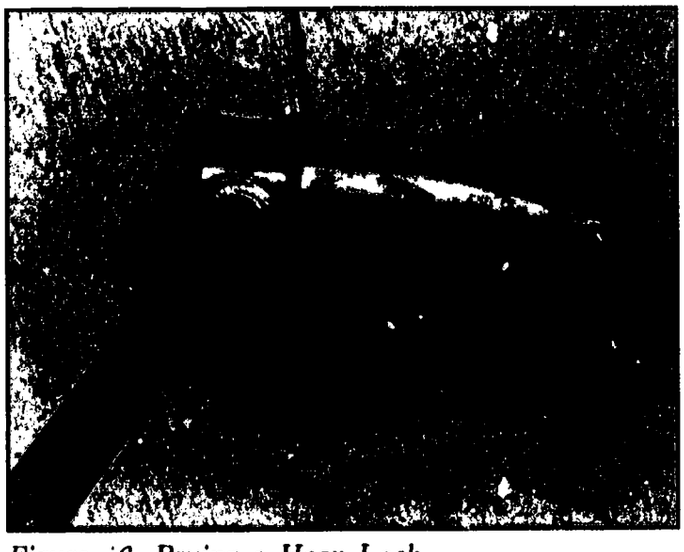


Figure 16. Prying a Hasp Lock

Overhead Lift Door. Overhead lift doors are easily operated once the lock is released (see Figure 17). Generally, they are locked with sliding bars that must be broken or sprung to release the door. Overhead lift doors may be forced by prying upward at the bottom of the door with a crow bar, claw tool, or other good prying tool. Once the lock bar is

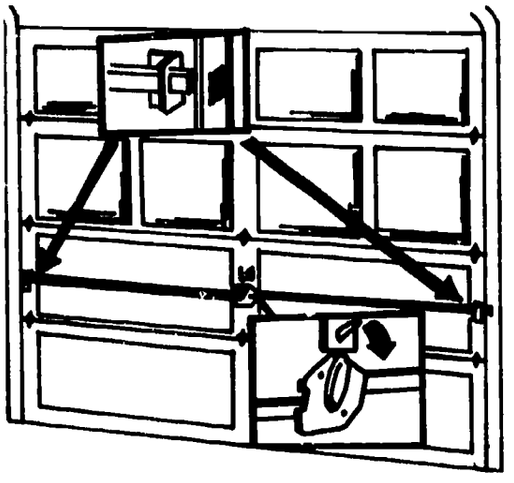


Figure 17. Overhead Lift Door

broken, the door will open easily.

Overhead rolling doors are made of steel and offer the greatest resistance of all to forcible entry (see Figure 18). Due to the fact that they are operated with a worm gear, the door cannot be raised except by operating the worm with the chain that is provided (see Figure 19). Prying the door is liable to spring it so that it cannot be operated even with the worm gear. There are two alternative methods to gain entry through a rolling door. The fastest method is to cut an opening through which rescuers may enter. The alternative is to knock out the wall alongside the door, making a hole large enough to operate the chain.

Tempered-Glass Door. The use of tempered glass or full-vision doors is increasing rapidly. Usually, there is no frame around the glass, and the locking hardware is either at the top or the bottom of the door. The tempering produces high-tension

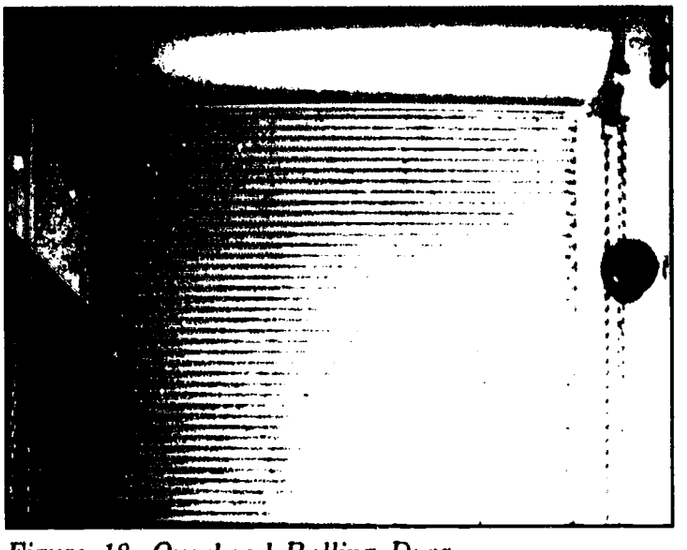


Figure 18. Overhead Rolling Door

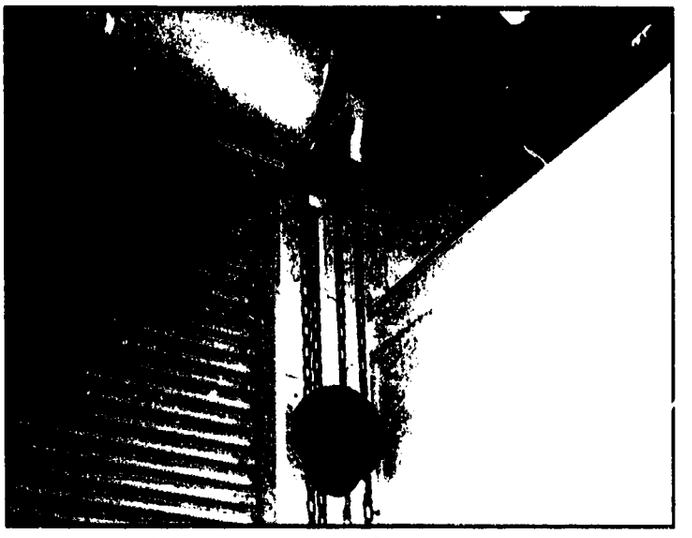


Figure 19. Worm Gear and Chain of Overhead Door

stresses in the center of the glass and compression stresses at the exterior surface. Tempering increases the flexibility and the strength approximately four times. It is more resistant to shock, pressure, and impact and will withstand, without breaking, temperatures of 650 degrees Fahrenheit on one side while the other is exposed to normal temperatures. Doors made of tempered glass are custom built and very costly. They should never be broken if any other means of entry is available.

Pulling Cylinder Locks

If necessary, the use of the K Lock Tool will enable entry by pulling the lock cylinder out of the door.

CONCLUSION

Throughout this chapter, the forcible-entry situations that are most commonly encountered have been addressed. It is possible that rescuers will encounter many different situations that are not addressed anywhere in text form. For this reason rescuers need to become familiar with the tools used in the local department, the buildings located in the vicinity of the department, and the preplanning activities and procedures.

STRUCTURE SEARCH AND RESCUE

KEY POINTS

The importance of search and rescue procedures
The primary search
The secondary search

INTRODUCTION

Rescue personnel are subject to great risk and are often injured while conducting search and rescue operations within a burning structure. When searching for occupants within a fire structure, do not disregard personal safety that could result with collapse. Rescuers must be in good physical condition, wear proper protective equipment, and wear proper breathing equipment (when required) during rescue operations.

One rescuer who fails to perform his or her share of a rescue could hamper the total rescue. Calling additional personnel to assist a fallen or injured rescuer, or the death of a rescuer or occupant within the structure will slow rescue procedures.

Throughout the search and rescue process maintain constant contact with the incident commander and report emergency conditions as they are found.

CONDITIONS OF THE RESCUE ENVIRONMENT

During structural search and rescue, evaluate the physical conditions to which the rescuers are subjected, not only as they relate to the building, equipment, and atmospheric degradation, but also in terms of the psychological effects these conditions have on the rescuer and the victim. Two psychological considerations are anxiety and exertion. Anxiety is the eagerness to serve or the desire to perform the rescue, the fear of the unknown, and concern for one's personal survival. Exertion is striving or laboring due to a rapid change of physical demands. Anxiety and exertion can be reduced by anticipating the stress, by mental discipline, and by the fact that the rescuer has had training and rescue experiences with the operation being performed.

For protection from excessive temperatures found during a search and rescue operation, wear approved protective clothing (helmet, hood, coat, gloves, pants, and boots) and use a self-contained breathing apparatus (SCBA). Protective clothing, as well as the SCBA, must be stored and cared for according to manufacturer's specifications. See the chapters on protective clothing and SCBAs.

The Victim's Condition

Be aware of the physical and emotional condition of the victim or victims. Each victim may react differently. The following conditions are commonly found.

- A victim's mobility may be affected by fire gases that can affect rational behavior
- A victim's field of vision may be greatly diminished or the victim may become disoriented from smoke conditions
- A victim may be irrational
- A victim may panic if the escape routes are physically blocked
- A victim may be in shock and unable to adjust emotionally to the rapidly changing situation
- An elderly victim or a small child may try to hide because of fear
- A victim may be under the influence of alcohol and drugs
- A victim may be physically handicapped or ill
- A victim may fail to recognize the severity of the fire or attempt to fight the fire rather than leave the building

Rescue personnel can also become victims on the fireground because of the following:

- Lack of protective equipment
- Equipment failure

- Becoming lost or disoriented
- An exhausted air supply
- Rapid fire development because of flashover, backdraft, building collapse, or explosion
- Overexertion

It is important that all rescue personnel be accounted for on a fireground throughout a rescue operation. It is essential to work in pairs in case one person becomes trapped or disoriented. When rescuers work in teams, the danger is shared and help is readily available in case there is a need. A team of rescuers also makes the response quicker by having four eyes to see and four ears to hear. Communication between team members usually reduces risk-taking by rescuers. Before entering any building to conduct a search, look for alternate exits, such as the doors and windows. Additional factors to consider include the following:

- Time. Be alert to the day of the week, the month, and the season of the year.
- Weather. Observe the humidity, fog, and temperature.
- Occupancy of building. Check to see if it is an individual residence, a single or multi-family dwelling, an educational facility, a public assembly facility, or a manufacturing site.
- Logistical. Evaluate the terrain of approach, the street or alley access, the exposures, and the number of personnel and equipment on the scene.
- Life hazard. Be alert to the life hazard for the occupants, fire personnel, and bystanders.
- Rescue operations. The incident commander should evaluate the need for company officers and rescue personnel.

THE PRIMARY SEARCH

All elements of search and rescue are important; however, during the primary search emphasize the conditions of the emergency and the purpose of the search. Begin the primary search immediately upon arrival at the scene.

In the case of a fire, conduct the primary search before the fire is under control. The search **must** be systematic (see Figure 20). Start on one side of the building and continue to search until every room in an assigned area has been checked. Never wander aimlessly within a burning structure. A rescuer can become lost or disoriented. Perform the primary search quickly and thoroughly. Do not overlook anything (see Figure 21).

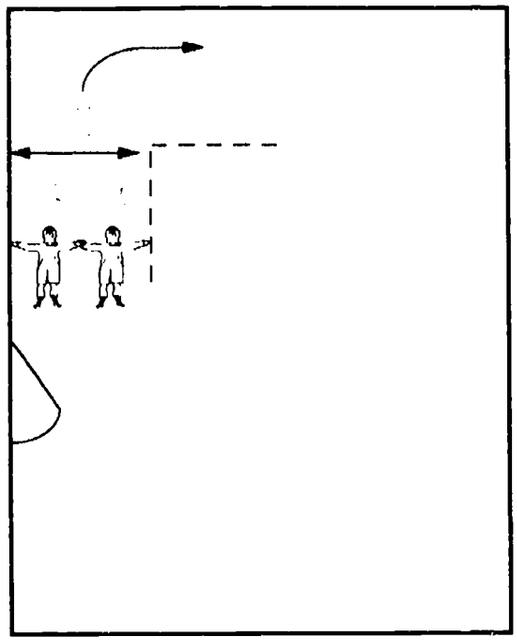


Figure 20. Search Pattern

One of the most dangerous parts of any burning structure is the floor directly above the fire. Always carry forcible entry equipment such as a Halligan tool or an ax that can be used to enter a room that is excessively hot, or to probe for victims who may have taken cover, e.g., under a bed.

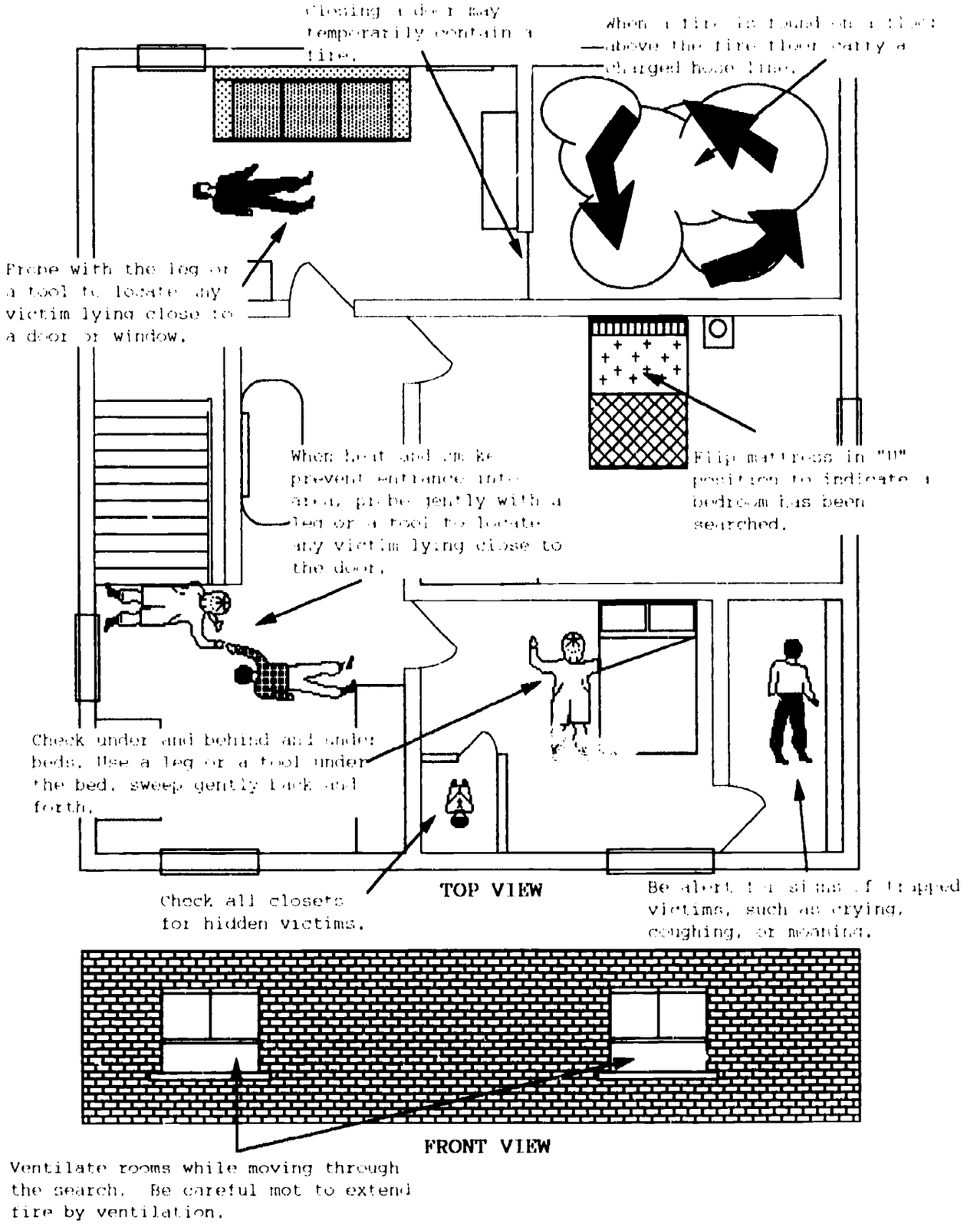
Also use forcible entry equipment to gain access to individual rooms and to assist in ventilating an area for the hose crew searching for fire. When ventilating, be careful not to draw the fire toward rescuers.

When searching a large open area, take a safety line inside the building to be searched (see Figure 22). The safety line must be tied to the rescuer, not to the rescuer's breathing apparatus. A hoseline can be used for this purpose. Carry a charged hoseline to extinguish fires that block an exit, and to contain a fire and keep it from extending to the search area.

The Search Process

During the search, move all furniture and search behind and underneath it. Children often try to hide from the fire and smoke, so it is important to search all closets and bathrooms.

When entering a smoke-filled area, look down toward the feet. If it is not possible to see the feet, drop to the hands and knees. Since heat and smoke tend to rise, this position allows greater visibility. It also helps rescuers find obstructions or holes in



Do not wander aimlessly, plan the search. Always move toward light, ventilation, and secondary means of exit.

Figure 21. Primary Search

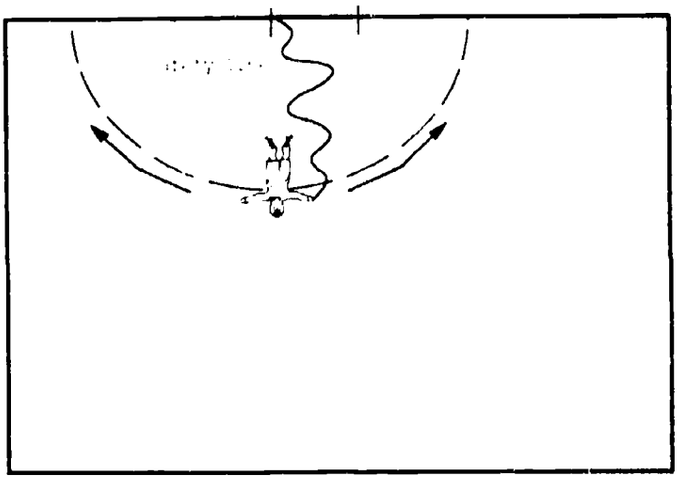


Figure 22. Safety Line

the floor, preventing injuries to the rescuers.

Before entering a room to be searched, feel the door for excessive heat. Never stand in front of the door. Keep the body low and to one side when opening the door. If there is a fire behind the door, as it is opened the fire will go above and away from the opening. Never kick in a door—a victim may be behind it. If a door is hard to open, slowly push the door open, feeling behind it to check for a possible victim who may have collapsed while attempting to escape.

If a fire is encountered during the search, trapped rescuers can protect themselves by closing a door behind them. This can contain the fire long enough to find a secondary exit, or for help to arrive.

Rescuers must also remember to keep their heads up when ascending or descending stairs. Always maintain a wide stance when going up or down stairways. This distributes the body weight over a greater area and decreases the possibility of structural collapse.

Once a room has been searched, mark the area to keep other teams from duplicating the search. Mark the rooms "searched" by some predetermined method such as placing furniture in the doorway, or placing chalk marks, tape, or latch straps over the door knobs. Whichever form of marking is used, make it known to all rescuers during training sessions that it is a standard operating procedure of the department.

Once the primary search team has completed the search, tell the incident commander the situation encountered, such as victims recovered, and the amount of fire extension. Also tell the incident commander when the entire search team is out of the building.

THE SECONDARY SEARCH

The secondary search is done by a second rescue team. This action ensures the thoroughness of the primary search and is usually conducted once the fire is under control. Use the same search techniques in the secondary search as in the primary search. Conduct the secondary search systematically. During the secondary search, attempt to identify victims not found during the primary search, check for fire extension, shut off utilities, locate danger areas (each should have been roped off and secured), and continue ventilation.

Search the outside premises in this phase of the search process. This action can provide information regarding victims who may still be inside, and information about the nature of the fire conditions from those who have already escaped. Check the windows and roof to see if anyone has jumped from the building. Victims may be on rooftops waiting to be rescued. Watch for victims trying to re-enter the building in an attempt to rescue another victim or obtain personal belongings.

For a rescuer who becomes lost or disoriented during a search, the following suggestions are helpful:

- Follow a wall to a window or door.
- Follow joints in the floor to find a wall.
- Look for light from a window.
- Go down a stairway. Never go up a stairway—fire gases and heat always rise.
- Follow a hoseline or a safety line.
- If a stairwell is not intact or safe, proceed to an adjacent room, find a window, and drop something outside in an effort to catch someone's attention.
- If the SCBA tank becomes empty, disconnect the breathing tube from the regulator and place it inside the turnout coat to obtain air trapped under the coat.
- Activate a personal-alert device.

After the Search

Once the search is completed, notify the incident commander of the conditions found within the structure. The summary report should include information about the status of the utilities, the fire extension, and the location of potential traps or hazards. The incident commander needs this information so firefighting crews working within the structure can be advised of the situation and obtain more assistance if needed.

When conducting a building search:

- Work systematically; follow a pattern whenever entering or exiting a room or building.
- Mark the points of entry and exit.
- Always work in a team of two or more and communicate continuously.
- Maintain contact with the wall and sweep the floor area; probe under, behind, and on top of all furniture, especially beds and chairs.
- Check all closets and bathrooms.
- Use the human senses of touch, sight, and hearing. Pause to hear moans, crying, gasps, or movements.

RESCUE OPERATIONS INVOLVING ELECTRICITY

KEY POINTS

- Characteristics of electricity
- Assessing the electrical emergency
- Equipment used for electrical emergencies
- Pulling an electrical meter
- Cutting the drip loop
- Responding to an emergency involving electricity
- Moving an energized wire
- Handling victims who are in contact with electricity
- Static electricity

INTRODUCTION

The most perplexing situation rescuers can encounter is a victim trapped by an energized wire. Most rescuers have a basic knowledge of electricity but do not possess the expertise to handle energized wires. Power company personnel are the experts in handling energized wires and must be used as a resource by the incident commander. When an electrical emergency occurs, the incident commander should develop a defensive plan of action, request assistance from the power company, reassure the victim, and wait for the power company's assistance.

Unfortunately, there are life-threatening situations in which the incident commander cannot wait for the power company and must intervene. It is not the intent of this text to make the rescuer an expert; its intent is only to show the safest techniques to use in life-threatening situations involving energized wires. These techniques must be practiced by rescuers, and a working relationship must be established between each department and the local power company. Power company personnel can assist in the development of standard operating procedures to deal with electrical accidents involving life-threatening situations.

ELECTRICITY

Electricity can be compared to water flow at the scene of a fire. Just as the fire engine serves as a pump for water, an electric generating plant serves as the pump for electricity (see Figure 23). At a fire scene, moving water is measured by how it moves in gallons per minute, while at an electric generating plant electricity is measured in volts.

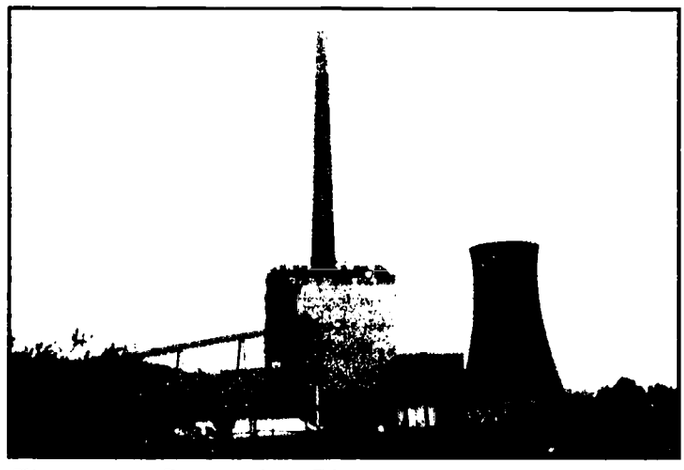


Figure 23. Generating Plant

From the generating plants, the electricity is passed through a series of wires and devices, just as in the pumper water flows through hoses of various sizes and different types of appliances. Electric plants produce electrical energy at very high voltages. The main distributing lines from the electric generating plant may carry up to 765,000 volts of electricity (see Figure 24). Electricity is distributed to various substations in local areas (see Figure 25) where it is divided into a lower voltage (approximately 15,000 volts) for further distribution.

The electricity then passes through transmission lines along local highways. Electric companies follow strict guidelines in the placement of electric lines on the poles. The rescuer should have a basic un-

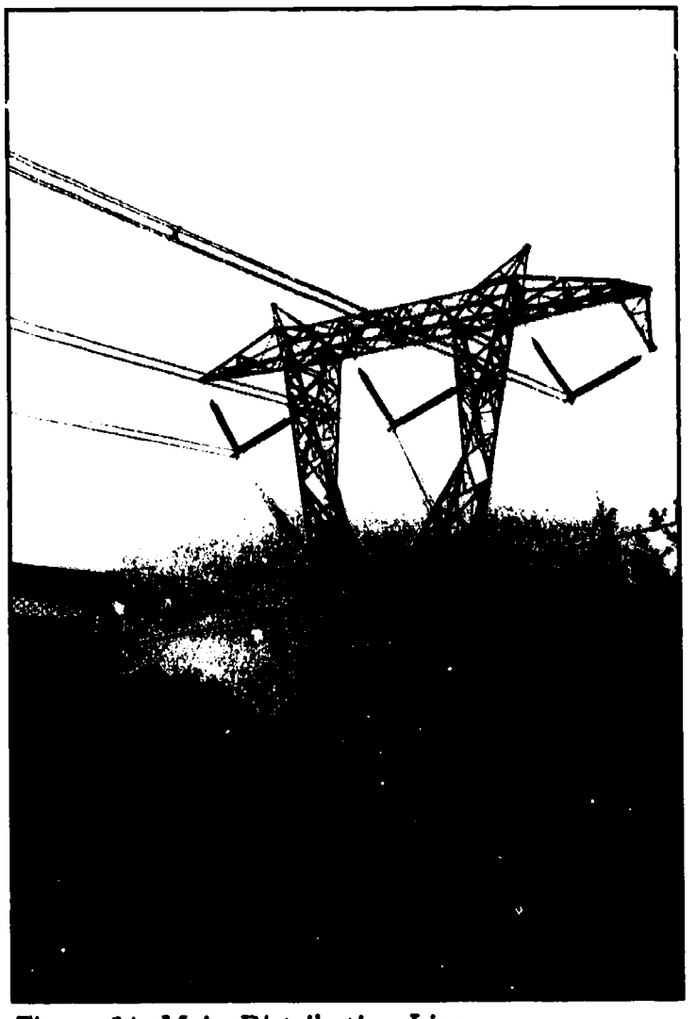


Figure 24. Main Distribution Line

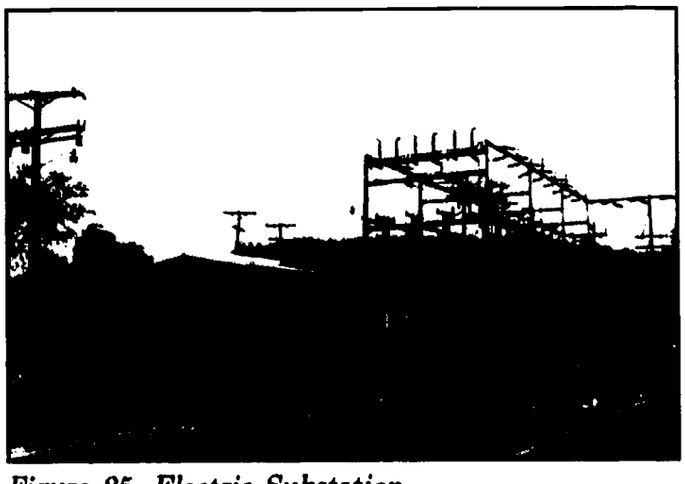


Figure 25. Electric Substation

derstanding of the placement of these lines. The highest lines are the primary lines (see Figure 26). The second highest lines are the secondary lines, and the lowest lines are the utility lines (TV cable and telephone).

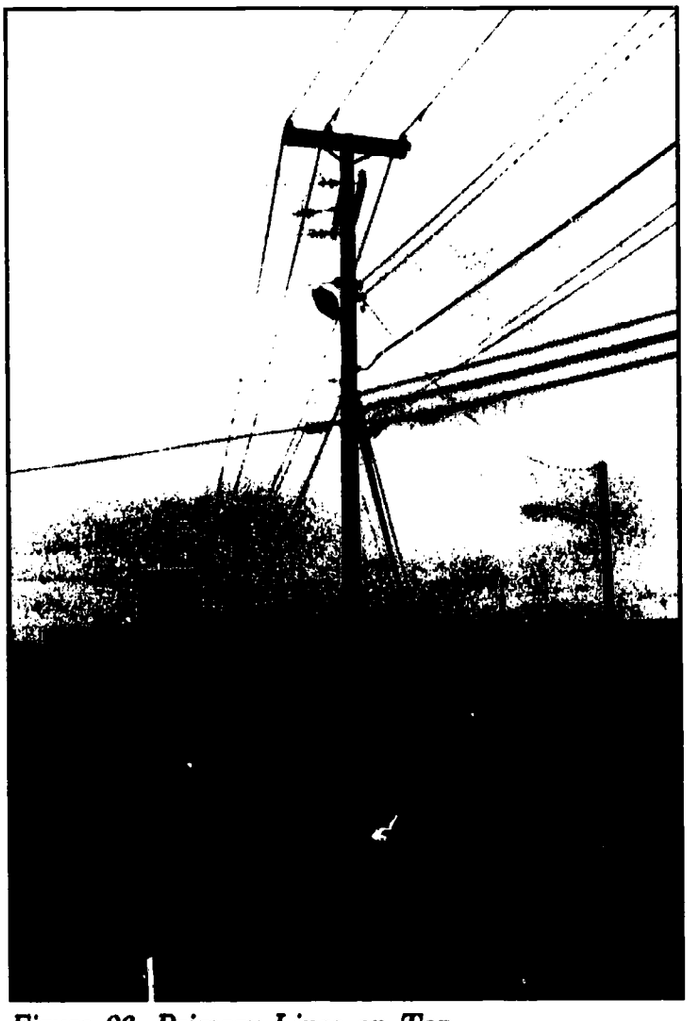


Figure 26. Primary Lines on Top

On some poles, a step-down transformer is located between the primary and secondary lines (see Figure 27). The purpose of the step-down transformer is to reduce the voltage to a usable 220 to 440 volts. This transformer may eigh as much as 1,000 pounds.

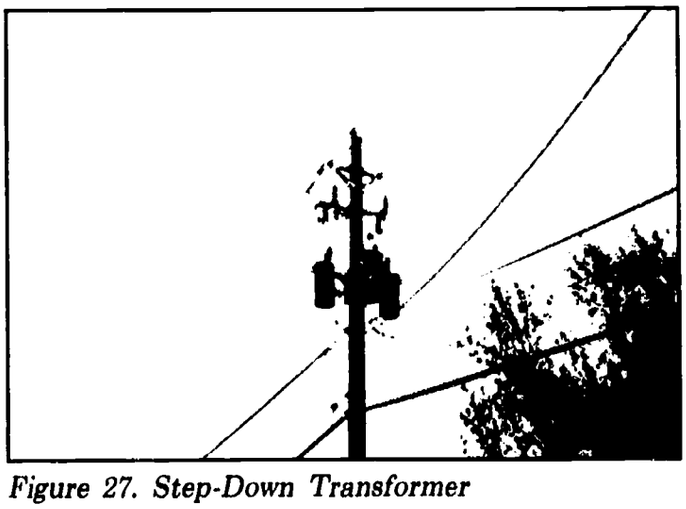


Figure 27. Step-Down Transformer

Use extreme caution when working around step-down transformers. Some of them contain a coolant called polychlorinated biphenyl or PCB. The transformers should be labeled as such and treated as a hazardous material. If the transformer is found to be leaking, notify a hazardous materials team to handle the situation.

From the pole, service lines run to a structure. A drip loop is formed as the service line wire enters the structure at the weatherhead (see Figure 28). In some residences, the service lines are buried underground (see Figure 29).

The service lines pass through a meter, which is not a switch but a measuring device. The meter should be in plain sight and located at the entrance of the service lines (see Figure 30).

From the meter, electricity is then carried to the fuse box or a circuit breaker box (see Figure 31). At this point, the electricity is divided into smaller circuits and distributed to different sections of a structure. A main disconnect switch is on the outside of the box. A main disconnect is also found at the electric meter, or if the meter is more than 5' from the box, there is a separate main disconnect switch.

The small circuits then pass through switches to receptacles or fixtures. Receptacles come in various styles. The two most common types are the grounded and non-grounded types. The non-grounded type is seldom used and does not meet most fire codes. Larger receptacles are used for 220-volt circuits, and are commonly found on machinery, stoves, clothes dryers, etc. (see Figure 32).

Electricity is used for hundreds of applications in homes and businesses. In its controlled form, electricity is a necessary fact of life and used by nearly everyone.

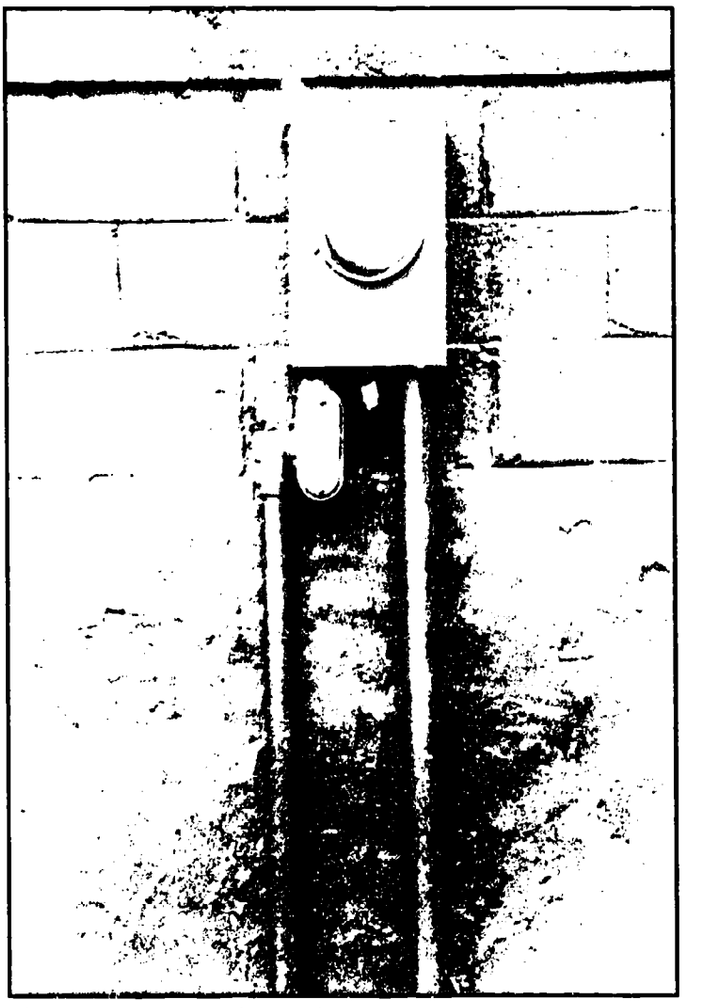


Figure 29. Buried Service

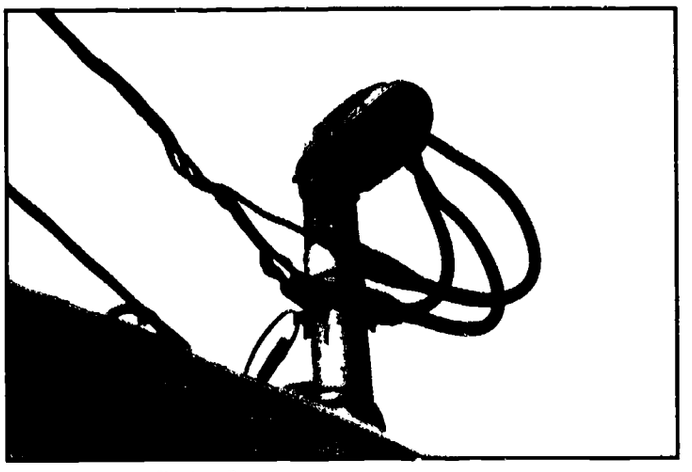


Figure 28. Drip Loop

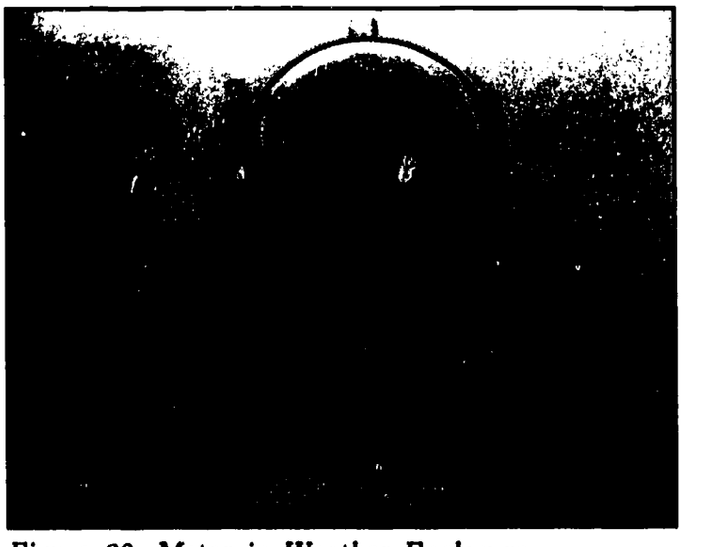


Figure 30. Meter in Weather Enclosure

Figure 31. Circuit Preaker Box

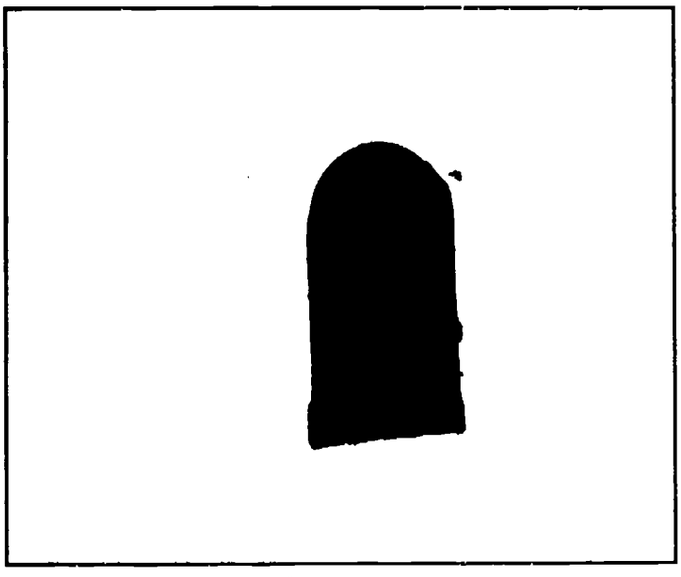


Figure 32. 220-Volt Receptacle

Assessing the Electrical Emergency

The rescuer must develop a respect for electricity—it can be of great service at the rescue scene. Electricity provides lighting and power for electrically-driven equipment, and is of great assistance in the rescue procedure.

When electricity is out of control it can be a killer. The rescuer must consider all wires as energized and dangerous, and secure all areas where electric wires are involved.

The rescuer who is conducting search, tunneling, or debris removal procedures must keep in mind that electrical hazards can be present. Downed wires can cause conduction through guardrails, fences, and wires not otherwise energized. The rescuer should proceed through debris with caution and with the backs of the hands turned forward. If the rescuer comes in contact with a live wire, the muscle contractions will pull away from the electricity. If the wire comes in contact with the palms of the hands, muscle contractions will cause the rescuer to grab the wire and be unable to remove the hands.

During all rescue operations involving electricity, secure the scene and establish a danger zone. In all nonlife-threatening situations, cut off the power at the fuse or circuit breaker box. Turn off the main switch to disconnect the power. If the main switch is not accessible, pull out the main buss fuses located at the top of the box or switch them to the off position. If the circuit breaker boxes are inaccessible, notify the power company as soon as possible.

In the event of a life-threatening emergency, it may be necessary to use dangerous techniques to disconnect the power. These procedures should be used only for life-threatening situations when power company personnel are not available, or their response time is too long to be lifesaving.

These attempts should be made only by rescuers skilled in such techniques and with the equipment available to handle the situation.

Equipment Used for Electrical Emergencies

The rope-weight tool is made of 100′ of 1/4″ or 3/8″ polypropylene rope with 4″ x 4″ x 4″ dry wood weights attached to each end through a hole in the center of the block. As the rope is brought through the hole, it forms a loop so it can be grabbed with a hot-stick or pike pole (see Figure 33). Polypropylene rope is used because it is nonconductive. Keep

Figure 33. Rope-Weight Tool

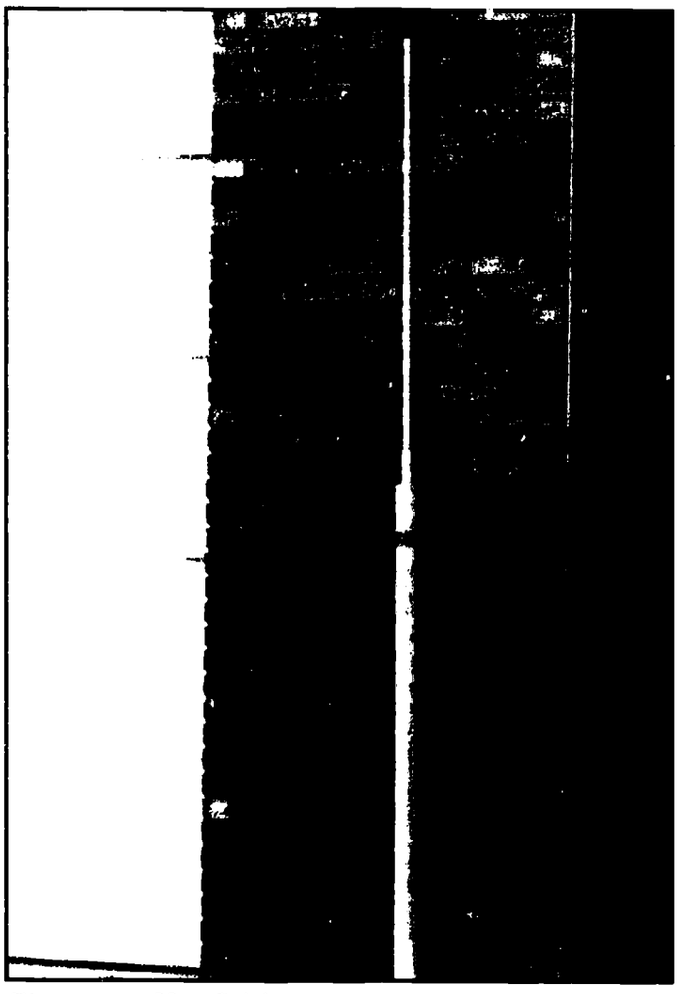


Figure 34. Hot-Stick

the rope clean and dry, and do not use it for any other procedure.

A hot-stick is a specially designed nonconductive tools used to move energized wires. The tool should be insulated and have the capacity to extend to 18' (see Figure 34). This tool allows the rescuer to work at a distance and not get too close to the wire. Some hot-sticks are made with a wire cutter at the tip and have an insulated handle to protect the user.

The wire-handling kit is a commercially-available kit containing a 16' telescoping pole with a pruning tool, a shepherd hook, and a plier attachment. A 3' rubber mat, lineperson's gloves, a gripping tool, and a wire cutter are also included.

Lineperson's gloves are elbow-length rubber gloves with leather protectors. Carry these gloves in a pouch and keep them in a protected area on the rescue vehicle.

Keep equipment used for electrical emergencies clean and dry at all times. Test the equipment regularly to ensure its reliability. Any small pin hole in the gloves or the slightest damage to the tools could prove disastrous to the rescuer. The power company may provide testing for electrical equipment upon request.

Wearing Protective Clothing

Using regular fire fighter's boots and protective clothing is not recommended for handling electrical emergencies. Fire boots are not the same as those used by the electric lineperson. Even though fire fighter's clothing is not enough protection, a rescuer should be in full protective clothing when handling any type of an electrical emergency. In addition to full protective clothing, stand on a dry rubber mat during the rescue operation.

Pulling an Electrical Meter

In a life-threatening situation where the fuse box

or circuit breakers are inaccessible, remove the electrical current by pulling the meter. This procedure must be approved by the incident commander and must be a standard operating procedure for the specific situation. Remember, when attempting any rescue procedure involving electricity, wear full protective clothing. Face shields must be down in place and the rescuer must be turned away from the electric wires when cutting or moving them.

The first step in pulling the meter is to remove the seal on the meter box. It is either a metal or plastic tab (see Figure 35). Simply cutting the tab will remove it. Then remove the outer cover from the box.

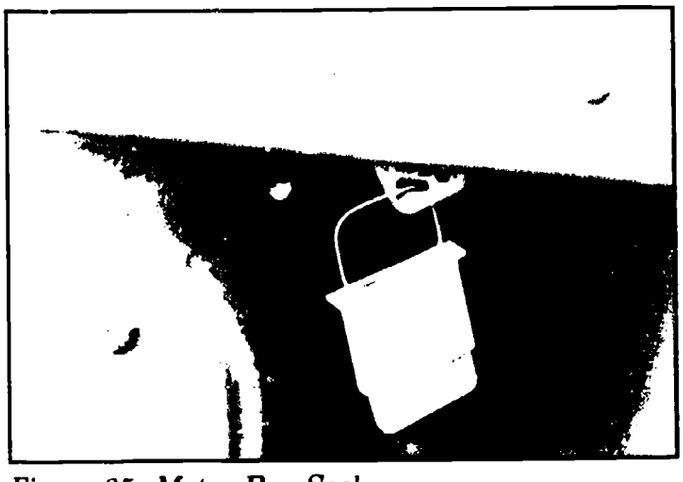


Figure 35. Meter Box Seal

Some meters are fastened to the box with bolts and cannot be pulled; however, most meters are usually held in place with a retaining ring. This ring is held in place with a screw or lift tab. To remove the lift tab, raise it and remove the ring by twisting. For the screw, carefully cut the screw with a pair of diagonal cutting pliers or a bolt cutter.

Once the ring is removed, the meter can be completely removed. Keep all unnecessary personnel away from the area. Turn away from the meter and quickly and forcibly push the meter down to remove the top tab. The top tab is attached to the service line. Once the tab is loose, remove the meter by continuing to pull the meter down and out of the bottom tabs.

Remember that there is still electricity in the meter box at the top tabs. Position a rescuer at the box to keep people away and prevent an accidental injury.

If the meter is humming and the meter wheel is turning very rapidly, there is a serious problem. Avoid a meter in this situation and **do not** attempt to pull the meter. Any attempt at pulling the meter can result in an explosion of the meter and injury to the rescuer.

Cutting the Drip Loop

An emergency method for disconnecting residential electricity is to cut the drip loop. Again, do this procedure only in life-threatening situations and never for commercial services. When cutting the drip loop, follow these suggested precautions: (1) wear full protective clothing; (2) cut only one wire at a time; and (3) cut the wire from the attachment to the structure and the weatherhead. If the service lines are cut before the building lines, energized lines fall to the ground, endangering the entire rescue operation.

Usually, three wires will be found entering the structure. Use only approved line cutters to make the cuts. Cut the top wire first, then the bottom line. Bend both wires away from the residence. The center wire, or the bare wire, is usually the neutral wire. Cut the neutral wire last and bend it **toward** the residence.

ELECTRICAL EMERGENCIES

Responding to an Emergency Involving Electricity

When approaching an accident scene, the incident commander of the first responding unit should attempt to identify any potential hazards. If an electrical line is downed or damaged, the incident commander should establish a hazard zone and communicate this to all responding units.

The hazard zone is the distance to the two adjoining utility poles on both sides of the accident. This zone should be secured and no persons should be permitted inside. This area must be secured as the hazard zone because an energized line can move in a circular radius equal to the distance between the two poles.

Once the hazard zone has been identified and secured, contact the power company to disconnect the power completely.

Responding to a Motor Vehicle Accident Involving Electricity

When a motor vehicle is in an accident that involves a downed electrical wire, the occupants of the vehicle may be protected by the rubber tires. Tell

the occupants to remain calm and to stay in the vehicle. If an occupant attempts to leave the vehicle and comes in contact with any metal on the vehicle and the ground simultaneously, electrical shock is possible.

If the occupant panics and attempts to get out of the vehicle, the rescuer may have to assist. Direct the occupant to open the door as wide as possible, stand with both feet on the rocker panels, and jump as far as possible away from the vehicle, keeping the arms at the side of the body.

If the occupant's injuries are life-threatening, attempt to remove the wire; however, only experienced personnel should attempt this type of rescue. Maintain the hazard zone until all electrical wires are controlled. All rescue personnel **must** be in full protective clothing, wearing lineperson's gloves and protectors to perform any of these rescue procedures.

Moving an Energized Wire

To move an electrical wire, approach the wire from each side. The person with the rope-weight tool should approach from the side opposite to where the wire is to be moved. Find the center of the rope and throw one weight **under** the wire. This will allow the rope to be pulled back if it is necessary to rethrow it. Then throw the other end over the wire. The rescuer on the other side should pick up the weights with the hot-stick and pull the rope and the wire out of the way. It may be necessary to use two rope-weight tools, one from each side of the electrical wire, to manipulate the wire to the desired location. Once the wire is removed, stabilize the wire and assign a person to watch the wire and keep people at a safe distance until the wire is under control.

Removing a Victim From Contact With a Wire

When a person is found in contact with an energized wire, make every attempt to de-energize the power source. If this is not possible, and the wire is not wrapped around the victim, remove the wire by using the hot-stick to push or pull the wire from the victim.

If a hot-stick is unavailable, use the rope-weight tool to loop around some part of the victim's body to drag the victim from the wire. Use extreme caution when moving a victim so as to not cause further body injury or pull the wire toward rescue personnel.

Removing a Victim from a Utility Pole

Call a rescue unit to remove an injured or ill lineperson from the top of a pole. The victim may have been injured on the pole or suffered an electrical shock, or may be experiencing a medical problem, such as a heart attack or diabetic reaction.

Upon arrival, establish and maintain a hazard zone. Then determine if the lines on the poles are electric lines. Many poles contain only utility lines such as TV cable and telephone lines, and do not present the threat of electric shock to the rescuer. If the pole does not contain electric lines, proceed with the rescue. If electric lines are connected to the pole, de-energize all wires before attempting any rescue. If the power company is on the scene, let the power company personnel de-energize the lines. If the power company representatives are not on the scene, notify the company. At no time should untrained personnel attempt to de-energize wires. Once the power is cut off, the power company must maintain these lines until the rescue is completed to assure that there is no accidental energization of the lines.

Most rescue personnel are not trained in the use of climbing gear. If the pole is accessible, the victim can be removed using an aerial apparatus. If an aerial is unavailable or inaccessible, raise a ground ladder above the victim. Climb the ladder and assess the victim. Place a lifeline and single pulley above the victim. If a body harness is available, attach it to the victim with the running end of the lifeline attached with a bowline.

If a body harness is unavailable, use a line rescue harness. Tie the harness by passing the running end of the lifeline through the victim's legs from back to front and around one leg (see Figure 36). Then bring the rope back under the standing part around the other leg (see Figure 37). Bring the end between the legs from front to back and tie it to the standing rope with a bowline and safety (see Figure 38). Next, place a half hitch in the standing rope, throw it over the victim's head and place it under the arms. Place a bight in the standing rope under the half hitch (see Figure 39). Next, place a bight in the standing part and pass it through the first bight. Pass the running end through the second bight and draw it tight (see Figure 40). Place a "safety knot" at this point. Finally, attach a guy line to the victim.

Raise the victim and remove the victim's lifebelt and climbing equipment. The victim can now be

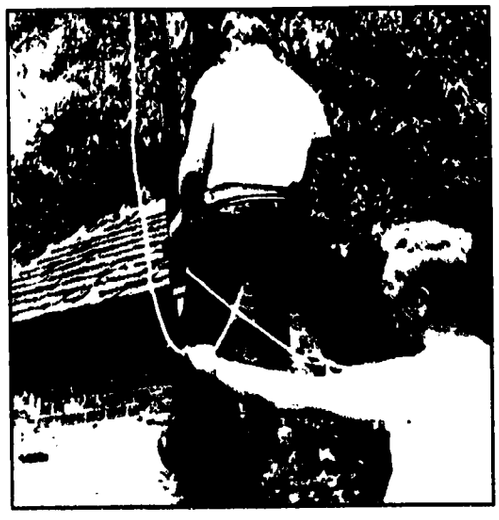


Figure 36.

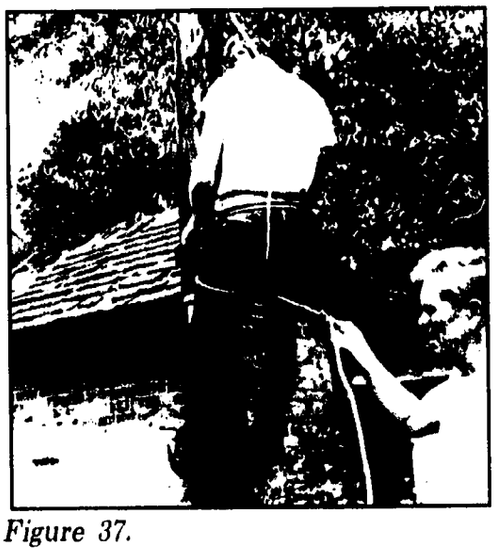


Figure 37.

Figure 38.

Figure 39.

Figure 40.

Figures 36, 37, 38, 39, 40. Lineperson's Harness

lowered to the ground using the guy line to keep the victim away from the pole.

Handling Static Electricity

Another form of electricity is static electricity formed by the friction of rubbing two different substances together. It may be impossible to prevent static electricity from forming but the rescuer must be aware of it.

Static electricity and sparks caused by friction can serve as ignition sources at rescue scenes. In the presence of flammable liquids, a spark can be disastrous.

When performing a rescue operation in the presence of a flammable liquid, ground the vehicle and/or container. To do this, drive a grounding rod into the ground approximately 10' from the vehicle. Attach a cable to the rod and then to the vehicle with a grounding clamp. Form a simple grounding clamp by welding a bolt to a pair of vice grips and attaching a wing nut (see Figure 41).

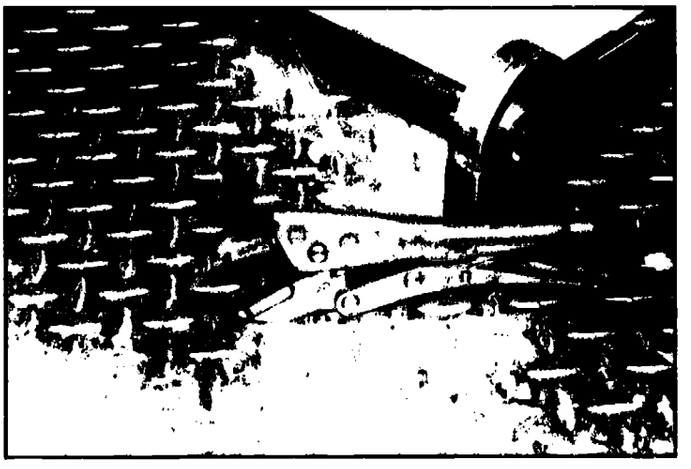


Figure 41. Grounding Clamp

Any time a metal ladder or piece of equipment is used in the rescue operation, it must be grounded to the tank containing the flammable liquid, also with grounding cables. Have various lengths of grounding cables with spring clamps on both ends readily available for such use.

WATER

Remember that water is a conductor of electricity. Keep this in mind during a rescue operation at the scene of a fire or during a rain storm.

Always avoid standing in puddles of water. High voltages can be conducted through water. If fire streams are used in the rescue operation, they should be used in fog streams. **Never** aim a straight stream at energized wires or equipment.

CONCLUSION

Handle rescue operations involving electricity with extreme caution. Be aware of local protocol in all rescue operations and electrical emergencies. The simplest electrical rescue procedure is to wait for assistance from the electric company when possible.

In life-threatening situations, a rescue attempt or an attempt by rescuers to de-energize the power may be necessary. These procedures should be attempted with extreme caution by trained personnel using safe equipment. If these specifications are not available, the only alternative is to wait for the electric company.

CUTTING TORCHES

KEY POINTS

- **Oxygen and acetylene cylinders**
- **Safe handling of the cylinders**
- **Principles of attaching the cylinders to the tanks**
- **Principles of operating the pressure regulators**
- **Cutting with the torch**
- **Safety concerns**
- **Exothermic cutting unit**
- **Safe operating procedures for exothermic cutting**
- **Cutting with the exothermic unit**
- **Precautions when using the exothermic cutting unit**

INTRODUCTION

On many occasions, rescue personnel are called in to extricate victims trapped by metal. Though it has been used primarily for cutting metal in industrial applications, the oxy-acetylene cutting torch can be used in rescue operations. **Due to the fire hazard and the potential of further harming a victim, it is important for any rescuer using a torch to be familiar with its correct use and its limitations, and to know how to properly care for it. Safety must be stressed to protect the rescue personnel as well as the victim.**

The oxyacetylene cutting torch can be used for cutting steel, wrought iron, and other ferrous metals. The equipment used must be portable and of a type will act efficiently and economically. Manufacturing companies will offer assistance in the selection of proper equipment. They will also supply the repair parts and check the equipment when necessary. Only trained technicians should repair this equipment. Follow equipment manufacturer's instructions when using the pressure regulators and the welding and cutting torches.

The cutting torch unit includes the following: two separate cylinders, one oxygen and one acetylene; two 25', 1/4" hoses; two pressure-reducing regulators; a cutting torch with a 90° head (see Figure 42); a friction lighter; a five-way wrench; a tip cleaner; one pair of leather gloves; and goggles.

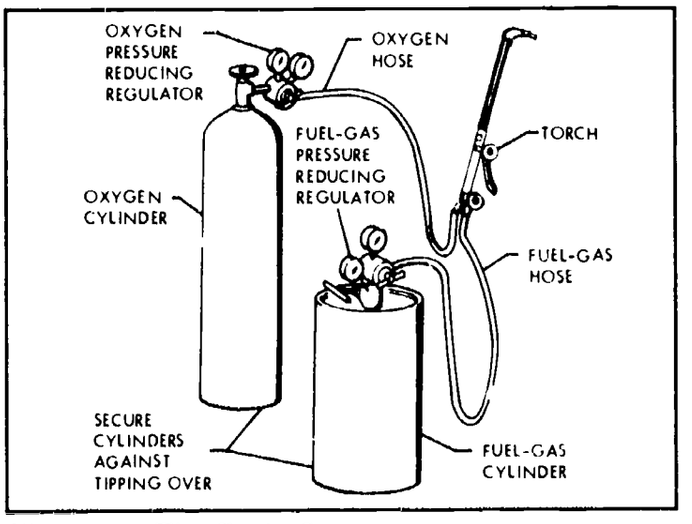


Figure 42. The Basic System

OXYGEN AND ACETYLENE CYLINDERS

The Oxygen Cylinder

Commercial oxygen used for the cutting torch is stored in steel cylinders. The manufacture of all commercial oxygen cylinders is controlled by the United States Department of Transportation. The cylinders are made of seamless steel with a frangible (bursting) disk in the valve at the top. This disk allows the gas to escape at a safe rate if the cylinder is subjected to a dangerously high temperature. Oxygen gas is pumped into the steel cylinders to a pressure of about 1800-2200 pounds to the square inch. Cylinders are made in various sizes, the two

most common having capacities of 110 and 220 cubic feet of gas.

The shut-off valves, mounted on the tops of the cylinders are of special design because of the extremely high pressure to which they are subjected. The valve stem has a right-hand thread, and when opened should be turned as far as possible. This prevents leakage by causing the valve to seat in the top of the valve body. Some manufacturers of welding regulators provide a small storage space for extra valve seats in the center of the cross bars.

Commercial oxygen is usually obtained from air. It is odorless, harmless to breathe, and non-flammable; however, it should never be used as a substitute for air. Oxygen supports and vigorously accelerates the burning of combustible materials; therefore, it is important to keep oil, grease, and other combustible materials away from the oxygen and oxygen equipment.

The Acetylene Cylinder

Acetylene gas is stored in special cylinders. The manufacture of these cylinders is controlled by the United States Department of Transportation. Unlike oxygen cylinders, which have no liquid or solid material inside, acetylene cylinders are filled with a porous material that is saturated with a liquid solvent called acetone.

Acetone has the ability to dissolve acetylene gas under pressure. The result is that when 220 cubic feet of acetylene are pumped into a cylinder of approximately the same size as the one used for oxygen, the pressure is 250 pounds to the square inch. This greatly increases the need for safe handling when transporting compressed acetylene. The acetone remains in the cylinder as the acetylene is allowed to escape during welding or cutting, and is used repeatedly with practically no loss. Fusible plugs in both the bottom and the top of each cylinder provide an additional safety factor.

Acetylene cylinder valves are not subjected to as much pressure as oxygen valves. The packing used in the valves is ample to prevent leakage. The valve stem has right-handed threads and should be opened only one and one-half turns to allow for rapid shut-off in case of an emergency. The valves are turned on with a T-wrench or hand wheel (see Figure 43). The T-wrench must be left on the valve until the cutting operation is concluded.

USE THE SPECIAL T-WRENCH TO OPEN ACETYLENE CYLINDER VALVES NOT MORE THAN 1-1/2 TURNS.

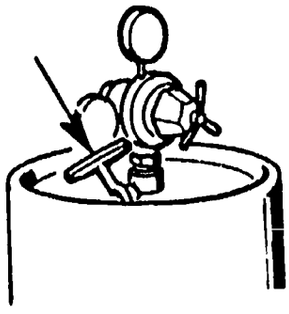


Figure 43. T-Wrench

Handling of Cylinders

Use only cylinders that bear Interstate Commerce Commission (ICC) or United States Department of Transportation (DOT) markings and that are clearly labeled Oxygen, Acetylene, or Propane. If a cylinder is not clearly labeled, return it unused to the supplier. It is illegal to tamper with cylinder markings or stampings. The following guidelines must be followed:

- **Always handle cylinders in an upright and secured position.**
- **Never lay an acetylene cylinder on its side.**
- **Never lay a liquid oxygen cylinder on its side.**
- **Never use any cylinder, full or empty, as a roller or support.**

Before moving or storing any cylinders, close the cylinder valves, remove the pressure-reducing regulators, and screw on the protective caps. When lifting single cylinders, never lift by the protective cap alone. Never use slings or electromagnets for lifting cylinders. Use hand trucks or racks for moving cylinders.

Never handle oxygen cylinders on the same platform with oil, or place them in a position where oil or grease from overhead cranes or belts is likely to fall.

ASSEMBLING THE TORCH

Attaching Cylinders to Tanks

Before attaching a fresh cylinder of gas to the cutting outfit, open the valve of each cylinder one-quarter turn and shut off immediately. This allows a small amount of gas to escape from the cylinder. The escaping gas blows out any dust particles that

may have lodged in the valves during shipment. This is called "cracking" the valve (see Figure 44). During this procedure, oxygen will not burn but acetylene will. Be sure there is no open flame nearby when the acetylene valve is opened. All fittings must be perfectly clean before being attached to a cylinder. Be sure all regulators are in the "off" or "loose" position before turning the gas on at the cylinder.

Figure 44. Cracking a Cylinder Valve

When turning the gas off at the cylinder, make certain the valves are completely closed. Then, open the two torch valves to "bleed off" any gas remaining in the hose. The pressure regulators will read zero.

Attaching and Operating Pressure Regulators

The rubber hoses from the torch fasten to two pressure regulators, one regulating the pressure of the acetylene gas in the acetylene hose, and one regulating the pressure of the oxygen gas in the oxygen hose. It is necessary to keep the pressures of the two welding gases constant at all times. Remember, the pressure of gases in the cylinders decreases constantly while the torch is in use (see Figure 45).

Turn the crossbar or handle of either pressure regulator to obtain the desired operating pressure.

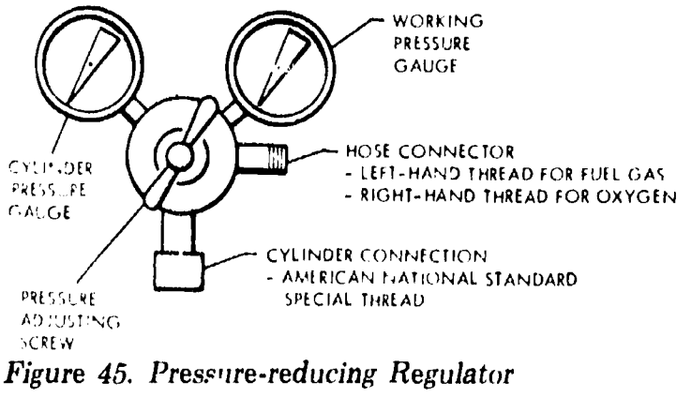


Figure 45. Pressure-reducing Regulator

Both oxygen and acetylene regulators have a crossbar with right-handed threads. The usual pressure ratio is five pounds of acetylene to thirty pounds of oxygen. The pressure is shown on the pressure gauge of the regulator. To increase the operating pressure, turn the crossbar clockwise.

Pressure regulators connect directly to the oxygen and acetylene cylinders; a second pressure gauge is located on each regulator to indicate the gas pressures within the cylinders.

If a torch acts up, it is quite possible that the regulators are at fault. Routinely following two procedures will prolong the life of regulators. First, always screw the crossbars out until they are loose before opening the cylinder valves located on the tops of the oxygen and acetylene cylinders. This prevents the suddenly released pressure from overloading and damaging the delicate valve mechanism inside the regulator. Second, never use oil or grease near a gas-welding outfit, or on any of the parts of the apparatus itself. Oxygen under pressure will occasionally cause oil to ignite if conditions are right. Oxygen alone does not burn, but it does accelerate the burning of combustible materials.

Connecting Gas Supplies to the Torches

Use only hose and connections specifically made for oxygen-fuel welding and cutting. Oxygen hoses are usually green, and acetylene hoses are red or black. Never interchange them. All connections must be made dry. Do not use pipe-fitting compounds, thread lubricants, oil, or grease. The connections to the regulator and torch must be made wrench-tight (not merely hand-tight) to ensure a leak-free connection (see Figure 46). The oxygen hoses use right-

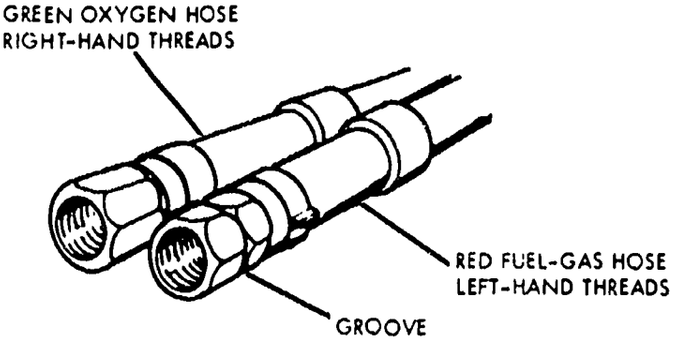


Figure 46. Hose Connections

handed thread connections and the acetylene hoses use left-handed, grooved thread connections (see Figure 47).

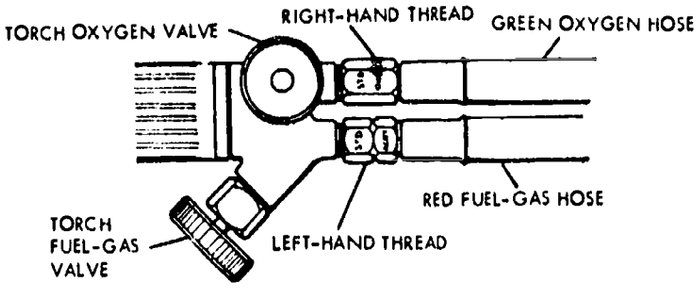


Figure 47. Hoses Used for the Cutting Torch

Assembling the Cutting Torch and Hose

The cutting torch consists of a handle and a torch body. To one end, any one of the various cutting tips, which range in size from 0 to 8, can be attached (see Figure 48). On the opposite end are two valves that control the rate of flow of oxygen gas and acetylene gas into the torch. The rubber hoses supplying the two gases are attached to these valves.

Always use an open-end wrench to tighten torch parts and hose connections; never use pliers. It is important to keep the packing nuts fairly tight on the torch valves so that the valve setting does not change while the torch is in use. Valves that turn easily can accidentally be thrown out of adjustment when they brush against something.

Cutting with the Torch

All types of cutting torches operate on the same principle and are provided with tips of various sizes for cutting metals of different thicknesses.

In contrast to the welding torch, which has a single orifice at the tip, the cutting torch has five or more orifices. The center orifice is surrounded by four or more orifices for the oxyacetylene preheating flames. The preheating flames are adjusted independently of the oxygen-cutting valve and, once adjusted, keep burning steadily, regardless of whether the oxygen-cutting valve is open or closed.

The oxygen cutting torch can successfully be used on any kind of steel or wrought iron, but not on cast iron, which is more difficult to cut.

First, select a cutting tip of suitable size for the thickness of metal to be cut. A No. 66 drill is suitable for cutting steel 1/4" thick; use a No. 52 drill to cut steel 1" thick, and a No. 48 drill to cut steel 3" thick. The larger the wire gauge drill-size number, the smaller the orifice used.

It is important to keep the orifice clean and round. Use tip cleaners of the correct size to clean the orifice. Slag sticking to the end of the tip can be loosened with a pocket knife without damaging the tip.

Check the torch, valves, and connections for leaks before lighting the torch. Do this by applying a soap solution and watching for air bubbles. Once the apparatus has been tested for leaks, adjust the acetylene hose pressure for cutting.

The oxygen operating pressure required depends upon the tip used and the thickness of the steel being cut. It will vary from 10 to 150 pounds. Charts supplied with torches indicate oxygen and acetylene pressure to be used for each tip and to cut each thickness of metal. Pressures vary with different manufacturers.

Open the oxygen valve on the torch body far enough to give full oxygen pressure through the torch for cutting; the torch is now ready to light. Always use a friction lighter to light a cutting torch. Do not use a match or a cigarette lighter (see Figure 49).

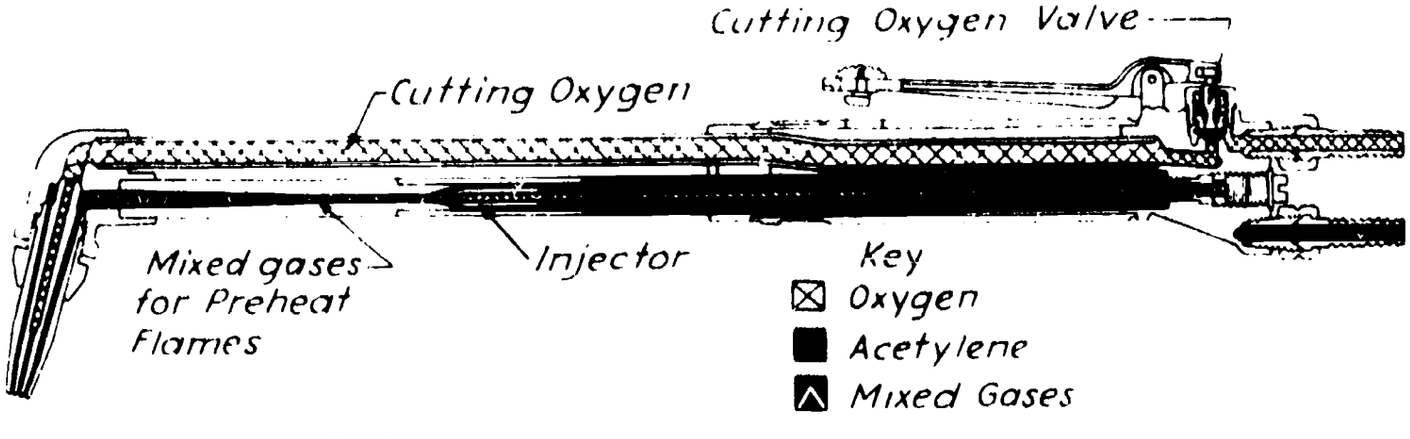


Figure 48. The Cutting Torch

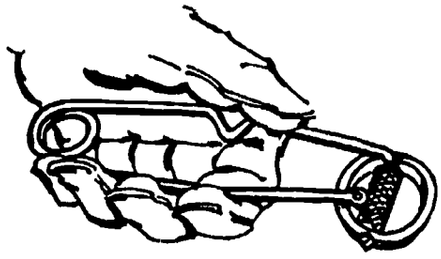


Figure 49. Friction Lighter

Next, adjust the preheating flames to neutral and try the cutting valve to see that full oxygen pressure is feeding through to the oxygen orifice in the tip. If the flames do not burn properly, shut the unit off and reclean the tip (see Figure 50).

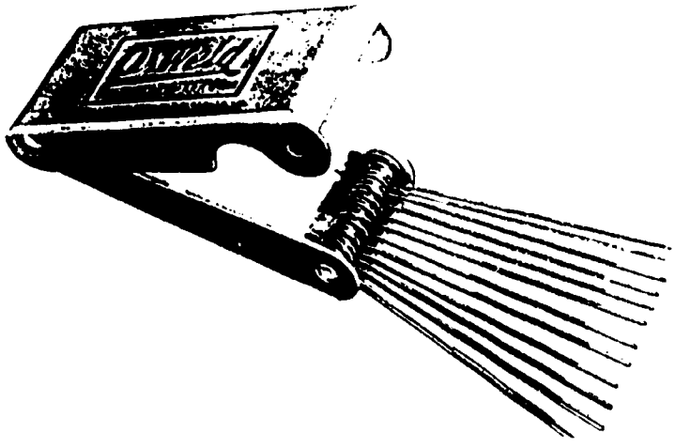


Figure 50. Tip Cleaner

With the luminous preheating cones of the cutting tip just touching the steel to be cut, heat the edge or other point where the cut is to begin. Be sure to have the torch well-supported and pointed at the work. When the steel begins to melt, begin to cut by slowly pressing down on the cutting oxygen-valve lever.

During the cut, keep the tip of the torch at a constant distance from the work. This will vary from 1/16" to 3/16" depending on the thickness of the metal. Do not change this gap as the torch is moved along the cutting line. Keep the bottom of the kerf or cut a little ahead of the top.

It is important to move the torch at a uniform speed, and at a speed slow enough to allow the oxygen to cut all the way through the metal. **When turning off the gas at the cutting torch, turn off the acetylene cylinder first.**

Backfires and Flashbacks

Improper operation of the torch may cause the flame to go out with a loud snap or pop, which is called a backfire. Investigate any such occurrence to determine the cause before relighting the torch. A backfire may be caused by touching the tip against the work, by overheating the tip, by a loose tip or head, or by dirt on the seat. Also, incorrect gas pressure can cause a backfire. Always use gas pressures recommended by the manufacturer. A flame that has backfired can be relighted at once provided there are no serious problems.

A flashback occurs when the flame burns back inside the torch, usually with a shrill hissing or squealing. If this happens, close the torch oxygen valve immediately, then close the fuel-gas valve. Closing the torch oxygen valve, which controls the flame, stops the flashback at once. Then, close the fuel-gas valve and allow the torch to cool before relighting. Also, blow oxygen through the tip for a few seconds to clear out any soot that may have accumulated.

When using a cutting torch, blow oxygen through the preheating and cutting orifices before relighting. Remember, when a flashback occurs, it indicates that something is radically wrong either with the torch or with the way it is being operated.

Protective Gear

Always wear the goggles supplied by the manufacturer when using cutting torches. The goggles must fit snugly so they will not slip when being worn (see Figure 51).

Figure 51. Protective Goggles

Guidelines for Handling Oxy-Acetylene Equipment

1. Do not compress acetylene or use it in a free state at pressures higher that 15 psi.

2. Use no oil on the cutting equipment or the hoses.
3. Crack the cylinder valves before attaching the pressure regulators.
4. Release the adjusting screws on both regulators before opening the cylinder valves.
5. Stand to the side of the regulator when opening the cylinder valves.
6. Open the cylinder valves slowly.
7. Purge oxygen and acetylene gas hoses individually so oxygen and acetylene are not mixed in the hose lines before lighting the torch.
8. Light fuel-gas before opening oxygen valve on torch.
9. Do not use oxygen as a substitute for air.
10. Take caution to protect hose from being cut by glass, sharp metal, or hot, molten metal.
11. Always wear proper protective clothing.
12. Check the pressure of tanks, and the operation of the pressure regulators and the torch frequently.
13. Read and follow manufacturer's instructions at all times.

Using a Torch to Extricate a Victim

Upon arrival at the scene, check the area for spilled fuels or gas fumes. No smoking can be permitted at the scene. Exercise care when using flares.

During the extrication of victims, the fire department must stand by with a charged hose line in case of fire. Also have dry chemical or carbon dioxide extinguishers ready for use. If it is necessary to cut metal near the victim, cover the victim with a fire-resistant or wet blanket. Rescuers must be continually aware of the potential fire hazards.

EXOTHERMIC CUTTING

A relatively new tool to use in place of the oxy-acetylene cutting torch is the exothermic cutting unit. Unlike other cutting equipment, the exothermic cutting system can cut, burn, melt, or vaporize a metallic, nonmetallic, or composite material.

In exothermic cutting, oxygen and a high-carbon steel rod are ignited to produce temperatures in excess of 10,000°F. The oxygen is delivered in a controlled amount through hollow coils in the center of the carbon steel rod (see Figure 52). The combination of the correct amount of oxygen with the carbon steel and an electrical spark causes the carbon

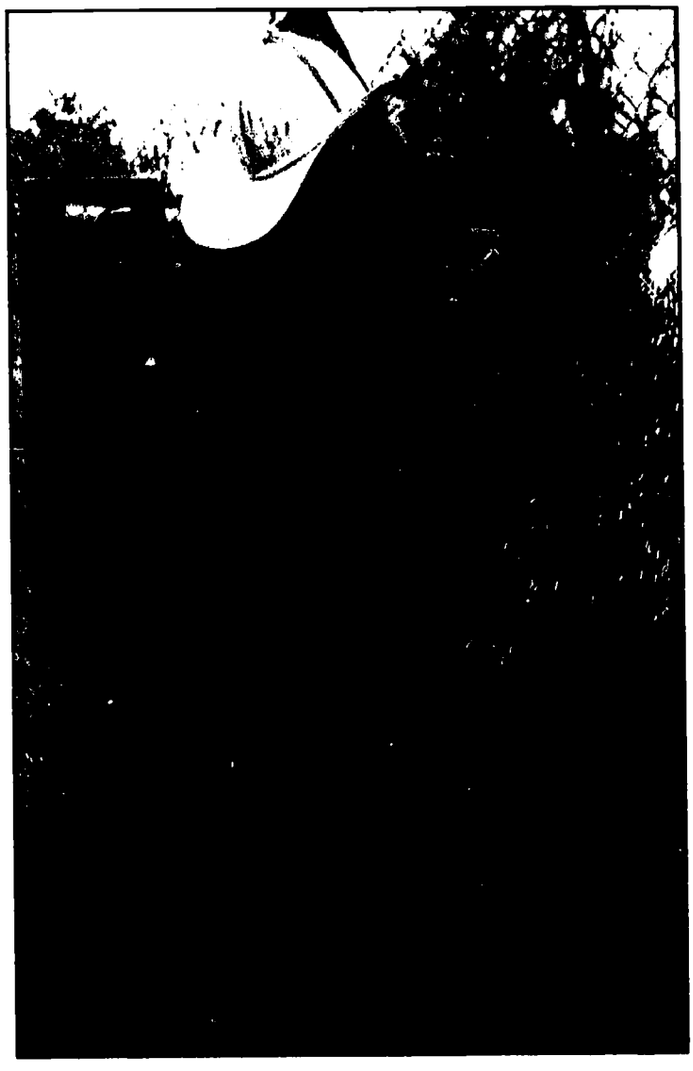


Figure 52. Exothermic Torch

rod to ignite and burn at the high temperatures needed for the exothermic cutting process.

The exothermic cutting unit, commonly called a slice torch, is available as a portable unit. It includes an oxygen cylinder with an oxygen regulator, a 12-volt battery, a striker assembly, a pistol grip with a heat shield, an oxygen control handle for attaching the rods, extra rods, and a carrying case.

Exothermic cutting has the advantage over oxy-acetylene cutting of being able to cut a wider range of materials, i.e., stainless steel, concrete, or glass. An exothermic cutting unit also cuts faster than a small portable oxyacetylene unit, especially when thicker materials are involved. In exothermic cutting, rescuers do not have to contend with the unstable flammable gas, acetylene. A major advantage of exothermic cutting is that using it takes less experience and skill than using an oxyacetylene unit. This is important in the rescue service, since personnel do

not use cutting torches daily. Thus, rescuers can learn to use the slice torch more quickly. There is less technical information (such as gauge settings) to remember.

Exothermic cutting does produce a larger amount of sparks, and often pools of molten metal. This situation can be controlled by applying a spray of water directly on the torch. This cannot be done when using the oxyacetylene torch.

As with any cutting tool, there are inherent hazards in using the slice torch. Combining oxygen and the carbon rod produces a very high temperature. Rescuers must be familiar with the operator's manual and be aware of all the warnings and necessary precautions. Rescuers should also be familiar with all the parts and their assembly and use. It is important that the user have actual hands-on training and some experience before using exothermic equipment. The major safety hazard in using the equipment is lack of hands-on experience.

Safe Operating Procedures for Exothermic Cutting

In using the slice torch, the following safety procedures must be followed.

1. Never permit oil or grease to come in contact with oxygen cylinders, valves, regulators, the hose, or fittings. Do not handle oxygen cylinders, valves, or regulators with oily hands or oily gloves, since oxygen under pressure combines with oil and grease with explosive violence.
2. Never use oxygen near flammable materials, especially grease, oil, or any substance likely to cause or accelerate fire. Oxygen itself is not flammable, but does support and accelerate combustion.
3. Do not store oxygen and flammable gas cylinders together. They must be stored separately and in a defined storage area that is dry, cool, well-ventilated, and fire-resistant. Keep cylinders protected from an excessive rise in temperature by storing them away from sources of heat, including direct sunlight. Cylinders must be stored in an upright position.
4. Always refer to oxygen as "oxygen" and not as "air".
5. Never use oxygen from cylinders or a piping system unless a suitable regulator is attached to the cylinder valve.
6. Never tamper with or attempt to repair oxygen cylinder valves or regulators.
7. Never use oxygen regulators, hoses, or other pieces of apparatus with any gases other than those for which they were intended.
8. Open the oxygen cylinder valve slowly, and then fully when in use.
9. Never enrich the atmosphere or closed areas with oxygen.
10. Never use oxygen to cool the work or the operator.
11. Do not let the arc or cutting flame come into contact with cylinders, cylinder safety devices, valves, regulators, or hoses. Fire or explosion could result from accidental flame contact with such items.
12. Inspect the oxygen regulator for evidence of damage or contamination. If there is evidence of physical damage or foreign material inside the regulator, return it to the manufacturer for repair.

    Do not attempt field repairs or modifications of any oxygen regulator.
13. Do not cut in combustible, flammable, or explosive atmospheres.
14. Always wear full protective fire-fighting equipment, including dry gloves and a hood, and eye protection with side shields. All rescuers assisting in procedures must wear complete protective equipment, including eye protection.
15. Protect the victim during the cutting with a noncombustible covering of some kind, (a screen and blanket).
16. Ventilate the area; the fumes and gases produced while using a cutting torch can be hazardous to the health. Do not breathe the gases and fumes.
17. Always have charged hose lines in place. Also have portable dry powder extinguishers nearby.
18. **Never cut any container that has held a flammable material; this could cause a violent explosion.**
19. Use special caution when cutting in a confined space.

Special Precautions

The exothermic unit is usually used around heavy equipment, such as mining, construction, or farm equipment. This equipment is so heavily constructed that it resists bending and distortion by hydraulic and air rescue equipment. It must be cut. Never cut

into any pressurized tanks or cylinders, such as the hydraulic cylinders often found on heavy equipment.

The torch is often used to cut steel beams, concrete, and re-bar in a building-collapse rescue operation. Be sure to know what the object being cut will do after the cut is completed. Have control of all pieces. Remember, dealing with objects of tremendous weight and possible unseen stresses and pressures presents a unique situation.

Never cut into any tank or cylinder that contains or has contained a flammable substance. Never use the torch in a flammable or explosive atmosphere. Always have a charged hose-line in position, as well as fire extinguishers. A spray of water can be directed on the cutting rod while cutting in emergency situations; however, this creates steam, making visibility poor.

Operators should always wear proper eye protection. Remember to provide adequate protection to any victim. Cutting creates a large amount of sparks and molten metal.

Cutting With the Exothermic Cutting Unit

The following step-by-step procedure is used to set up and operate the exothermic cutting torch. Always follow the guidelines from the operator's manual provided by the manufacturer for the specific type of equipment used.

Preparing the Unit for Cutting

1. Remove the torch handle from the carrying case and loosen but DO NOT REMOVE the collet-nut assembly.
2. Insert the cutting rod into the hole in the collet-nut assembly. Make sure the rod is firmly seated against the washer inside the torch. This may require tapping the rod against a hard surface.
3. Remove the striker plate and cable from the case and prepare to use.
4. Turn the oxygen regulator on slowly; when the high-pressure gauge indicates maximum pressure, open the cylinder valve fully.
5. With the torch valve closed, adjust the pressure regulator to approximately 80 psi. The torch is now ready for lighting.

Lighting the Torch

1. First, check to see if oxygen is flowing through the rod by squeezing the handle completely closed for approximately two seconds. If flow is not obvious from the end of the rod or if flow is detected around the collet nut, remove the rod and replace it.
2. Hold the striker in one hand and the torch in another.
3. Start the oxygen flow by squeezing the oxygen lever on the handle. (Squeeze handle fully.)
4. Place the rod against the exposed serrated metal on the striker at a 45° angle, and rock it back and forth.
5. When the rod ignites, immediately remove the rod from the striker. (Failure to do so results in the striker being cut.)

Rods often go out after the initial lighting. If this happens, repeat the above steps. If the rod goes out repeatedly, use another rod. CAUTION: The rod end may be hot. Also, a rod can ignite on any hot surface. **To extinguish the rod, simply stop oxygen flow by releasing the oxygen lever.**

Cutting With the Torch Unit

CAUTION: The intense cutting flame of the exothermic torch creates a large spray of molten cut material.

1. If possible, start a cut on an exposed edge of the material. If this cannot be done, try piercing the material. (See "Piercing a Surface" in this chapter.)
2. Be sure the cutting rod is ignited before beginning the actual cut. Be sure hoses and wires are clear of the cutting area.
3. Hold the rod at an angle to the piece being cut. As a rule, the thinner the metal, the less the angle. For example, when cutting a sheet 1/8" or thiner, use a 15° angle; up to 1" thick steel, use a 70° angle. Metals 1" thick or thicker require the use of a sawing-type motion, as well as the 70° angle.
4. Cut by pulling the torch towards the body. Support the rod with a gloved hand, but never allow the burning end to come into contact with the hand. Pull the rod slowly enough to cut completely through the material in a smooth motion. Pulling it too quickly does not allow for a complete cut through.

   Aluminum produces one of the most violent reactions to the high temperature. Because it melts quickly, aluminum will cut faster and produce more sparks than any other material. All thicknesses of aluminum require using a 70° angle and extra precaution.

The angle of the cut may need to be adjusted from job to job. Use the following chart as a guide (see Figure 53).

5. Remember, for successful cutting the end of the cutting rod should lightly contact the piece being cut. Holding the rod as little as 1/4″ to 1/2″ away results in little or no cutting. Since the rod is consumed during cutting, the operator must constantly shove in on the torch to keep the rod in direct contact.
6. Stop cutting when the rod becomes shorter than 3″, and replace the rod.
7. The proper procedure for stopping the cutting process is to first pull away from the cut, and then release the oxygen. Releasing the oxygen while still in the cut often results in plugging the oxygen outlet, thus making relighting of a partially-used rod impossible.

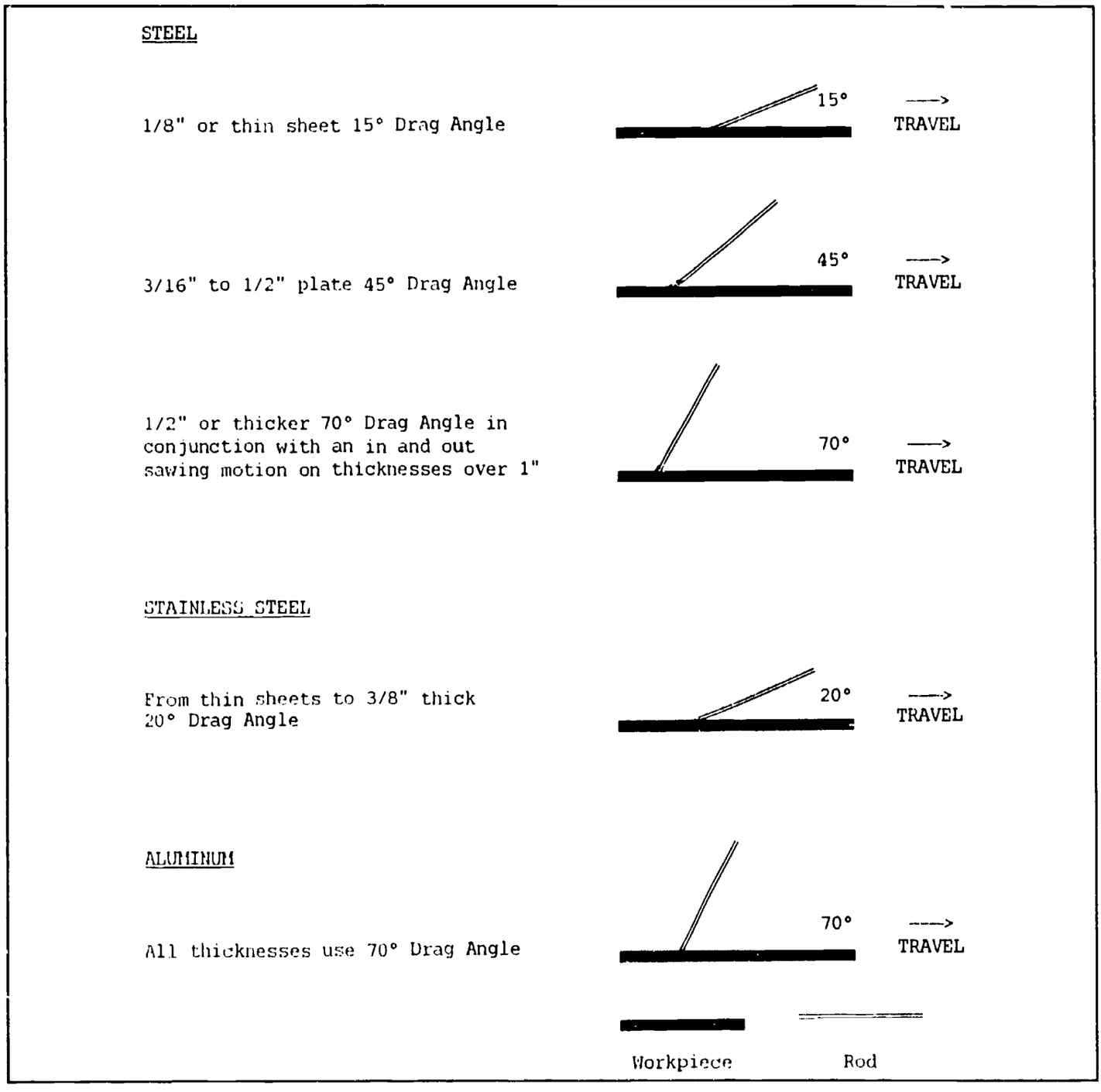


Figure 53. Cutting Angles

NOTE: Releasing the oxygen lever will stop the burning of the rod.

Loss of Cutting Flame

Sometimes the flame may be extinguished while cutting. To restart the torch, follow the standard ignition procedures. If the cutting rod continues to go out, use the following procedure:

1. Slow the cutting speed. Moving the torch too fast may create an incomplete cut, which can result in blowing ou the flame.
2. Check the oxygen regulator for the correct oxygen pressure.
3. Check the tank for low oxygen.
4. Check the angle of the rod to the piece being cut.
5. Check the oxygen path in the rod to be sure it is not blocked. If it is, replace the cutting rod with a new one.

Piercing a Surface

The slice torch can be used to cut a hole through solid materials when there is no exposed edge to start an initial cut. This procedure is called piercing.

CAUTION: Piercing a surface produces a violent reaction and creates the most dangerous conditions for using the torch. Piercing should be done only when absolutely necessary. Maximum protection must be provided for the operator, nearby personnel, and the surrounding area. A flashback of sparks and molten material does happen. Piercing should be done only by someone experienced in cutting with this tool.

Use the following procedure to pierce a surface:

1. Be aware of what material is behind the pierced hole.
2. Hold the torch at arm's length.
3. Bring the rod in at a 90° angle, that is, perpendicular to the pierce point.
4. Hold the end of the burning rod about 1/2" from the pierce-point and preheat the area for a few seconds. Then, slowly push the cutting rod into place until a burn-through is achieved. This is signalled by a large amount of blowback.
5. To prevent the cutting rod from getting stuck inside the pierced hole, slowly swirl the cutting rod as it enters the pierce hole.
6. If possible, remove the cutting rod from the pierce point before releasing the oxygen lever.

CONCLUSION

The use of cutting tools in rescue operations is often necessary to free trapped victims. Rescuers must be knowledgeable in the setup and operation of the oxyacetylene torch and exothermic unit. Due to the possibility of a fire being started, special precautions are required when using these tools. Training, practice, and experience are essential to safe operations in all cutting procedures.