A technical manual for the Rescue Service / prepared by the Rescue Section, Medical Division, of the U.S. Office of Civilian Defense.

A Technical Manual for the Rescue Service

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Prepared by the RESCUE SECTION, MEDICAL DIVISION, *of the*
U. S. OFFICE OF CIVILIAN DEFENSE

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Preface

This manual for the Rescue Service describes the important technical apparatus and operations which are necessary in rescue work. Workers skilled in the required technics should be enlisted to direct and carry on the Rescue Service whenever possible. However, as the manpower shortage will force many communities to recruit and train inexperienced and unskilled workers for the Rescue Service, sufficient technical material has been included to introduce the subjects of reconnaissance, shoring, tunneling, handling of ropes and ladders, and protection against common (nonwar) gases. The manual is not exhaustive, but may serve the rescue worker as the basis for further study.

Contents

Introduction

War from the air accompanied by widespread bombing of civilian populations brings with it the problem of rescuing casualties from the debris of demolished buildings. To every bombing incident where casualties are trapped, Rescue Squads must be dispatched to release them. If such services are not provided or should they prove inadequate, men, women, and children will die needlessly and the morale of the people may be severely shaken.

In most mass raids there are also many fires. Great conflagrations are caused by incendiary bombs, which require the entire personnel and equipment of the Fire Service if a city is to be saved from destruction. Although rescue of persons from burning buildings must continue to be the responsibility of the fire department, experience has shown that a large number of those injured in air raids are trapped in demolished buildings where there is no fire. During a raid and as long afterward as there are fires to be fought, firemen can not be spared to dig laboriously into ruins for people trapped in the debris. This type of rescue requires special technique and equipment employed by a Rescue Service of trained and disciplined workers under experienced leaders.

A Rescue Service has been established in the U. S. Citizens Defense Corps. It is a specialized service, since rescue work demands a high standard of skill and much experience. It requires the ability to remove quantities of materials safely and speedily, to tunnel through debris and to support the walls and roof of the tunnels made, to work safely in dust or gas-filled spaces, to render such emergency care as may be needed before moving crushed and injured people, and to move casualties safely to a place where they will receive further care by the Emergency Medical Service. The manner in which the injured are recovered from beneath structural debris and the skill with which they are moved will often determine their chances of survival.

The purpose of this manual is to provide members of the Rescue Service of the U. S. Citizens Defense Corps a guide for the organization and technique of rescue work. In preparing the manual various sources of information have been drawn upon, including publications of the Office of Civilian Defense, the War and Navy Departments, the Bureau of Mines of the Department of Interior,

extent upon the Chiefs of the Emergency Services who serve on his staff and are members of the Staff Unit of the Citizens Defense Corps.

During periods of actual or practice operations the Commander, with the assistance of the Chiefs, directs the Emergency Services from a Control Center which has special communication facilities, including telephones, messengers, and often, short wave radios. Messages flow into the Control Center from Air Raid Wardens and others in the field. The changing situation is plotted on a large wall map visible to the Commander and the Chiefs. On the basis of the information thus received, personnel and equipment of the various Emergency Services are dispatched from their stations or depots to the points of need.

The Emergency Services over which the Commander of the Citizens Defense Corps exercises control are the following:

Raid Services	*Post-raid Services*
Emergency Police	Emergency Public Works
Emergency Fire	Emergency Utilities, including Water Supply
Air Raid Wardens (including Fire Guards)	Emergency Welfare
Rescue	
Emergency Medical (including ambulances)	
Staff	

The raid services will find it necessary to continue after a raid or other wartime disaster until they have completed their work. The post-raid services do most of their essential work after a raid, although crews or squads of workers may at times be dispatched to an incident during a raid if there is need for their services.

Units of the various protection services are dispatched to incidents by the chief of the service or his designated representative on duty at the Control Center, subject to the direction of the Commander or Controller. Because of the increasing intensity and brevity of air raid bombing (the new "saturation bombing technique"), only the minimum essential number of Rescue Squads will be sent from their depots to incidents during a raid. Excessive movement of civilian defense personnel through streets during a raid exposes them needlessly to danger and increases the number of casualties.

The organization of the U. S. Citizens Defense Corps and the training required for membership in the Corps are governed by Regulations No. 3 (revised August 1943) issued by the Director of the U. S. Office of Civilian Defense. Regulations Nos. 1 and 2 govern, respectively, the use and method of distribution of equipment loaned to com-

munities by the Office of Civilian Defense, and the manufacturing, distribution and use of the Office of Civilian Defense insignia.

The regulations permit trainees who are duly registered as such in the local Citizens Defense Corps and are undergoing approved training to wear, when necessary, arm bands and other identifying articles marked with a "CD" in red. They are also entitled to use, for training purposes, equipment loaned to the community by the Office of Civilian Defense.

The insigne of the Rescue Unit consists of the basic OCD pattern, the white equilateral triangle on a circular field of blue, containing in the center the identifying device of the Rescue Service, the red ladder.

CHAPTER II

Organization of the Rescue Service

In a community, the Rescue Service is a part of the Citizens Defense Corps. It consists of a Chief appointed by the Commander, an Advisory Committee appointed by the Chief with approval of the Commander, and of Rescue Squads of 10 men each, recruited and trained for the arduous duties they are to perform. The Squads are based on Rescue Depots where they store their equipment and where they assemble for training and practice. The Chief of Rescue Service may, with the approval of the Commander of the Citizens Defense Corps, appoint deputies to assist him in administering the Rescue Service.

In order to assist in the development of the Rescue Service, the U. S. Office of Civilian Defense has created a Rescue Section in the Medical Division of the Protection Branch and has assigned Rescue Officers to the Regional Offices (coterminous with Army Service Commands) in the target areas. Many States have appointed State Rescue Officers. The organization of the Rescue Service and the local-State-Federal relationships are further explained in Operations Letter No. 133, which is included in Appendix B, page 130.

LOCAL CHIEF OF RESCUE SERVICE

The duties of the local Chief of Rescue Service fall under the following headings:

1. *Administration.*—Recruitment, discipline, and organization of the Rescue Squads.

2. *Training.*—Preparation, execution, and general supervision of the training of all local rescue personnel.

3. *Operation.*—Supervision, either directly or indirectly, of rescue operations.

4. *Equipment.*—Provision from local sources of necessary equipment, vehicles, etc., as needed.

At least monthly, the local Chief of the Rescue Service should check the inventory of equipment and report to the Property Officer any loss, damage, or breakage. He should also check with Drivers the log of operations and the status of greasing, oiling, and maintenance of the trucks.

In large cities where the Rescue Service comprises many Squads, much of the work must be delegated by the Chief of the Service to his deputies.

ADVISORY COMMITTEE

The Chief of Rescue Service may find it useful to appoint, with the approval of the Commander, an Advisory Committee on Rescue. Such a committee will prove particularly valuable during the period of development of the Rescue Service. The Chief of Rescue Service should act as Chairman of the Advisory Committee, which should include, in addition to the Chairman, representation from the Associated General Contractors of America and other important industrial organizations, from the Regional Supervising Engineer of the Health and Safety Service of the U. S. Bureau of Mines (if available), and others with special qualifications in fields related to rescue work. The local Chiefs of the Fire and Emergency Public Works Services should be included as members of the Advisory Committee. Such a committee will prove helpful in recruiting volunteers required for the Rescue Service, arranging for the use of special equipment, determining the number of squads needed in the community, and coordinating with the Rescue Service the related activities of the other emergency services. Meetings should be held with sufficient frequency to maintain the interest and active cooperation of the groups represented.

THE RESCUE SQUAD

After satisfactory completion of basic training and enrollment in the Citizens Defense Corps (Regulations No. 3, United States Citizens Defense Corps, Revised August 1943) members of the Rescue Service are organized into Squads. The standard Rescue Squad consists of a Leader, an Assistant Leader, a Driver, and 7 other members.

The latter should, wherever possible, be proportioned as follows:

2 men familiar with trenching, tunneling, and shoring.

1 building wrecker.

1 mechanic, familiar with the care and operation of such equipment as may be brought to the job.

1 first-class carpenter or timberman.

2 coal or hard-rock miners, tunnel workers, quarrymen, or allied mineral-industry workers trained and experienced in mine-rescue work. In some communities it may not be possible to find men with this type of experience.

About 25,000 men in various parts of the country have been trained by the U. S. Bureau of Mines in mine and tunnel rescue work. These

men have also been trained in the type of first aid work required in rescue operations. In addition to miners and tunnel workers, similarly trained men are employed by various industrial corporations. Wherever possible, the services of such experienced personnel should be enlisted in organizing and training the Rescue Service.

THE SQUAD LEADER

The Leader of a Rescue Squad should be a good organizer and director of men. It is desirable that he be familiar with the construction of buildings and with tunneling and supporting or shoring of loose materials, although this is not necessary if other men skilled in this work are in the Squad.

The Leader's job is to retain a continual grasp of the situation and maintain effective control at the incident until the work of rescue is completed. He must make a systematic reconnaissance in preparation for his work, carry it out in an orderly sequence, and keep a careful record of what is done. Except in emergencies, therefore, he should not engage in actual rescue work but should hold himself free to supervise and direct the operations.

It is the Leader's duty to cooperate with the other Emergency Services; to exchange ideas with the Leaders of other Squads; and to arrange a roster so that the men can, when necessary, be quickly called to duty either at the Rescue Depot or elsewhere.

THE ASSISTANT LEADER

The Assistant Leader of a Rescue Squad should be able to assume the leadership of the Squad when necessary. His function during action and at other times should be to take his place in the Rescue Squad as directed by the Leader.

THE DRIVER

The Driver requires special training in driving under emergency conditions, particularly blackouts. It is the Driver's duty (1) to make sure that the vehicle assigned to him is maintained in first-class condition and is adequately provided with necessary operating supplies; (2) to see that equipment is loaded and properly stowed on the vehicles; (3) to act as storekeeper of the vehicle and equipment whenever the occasion requires; (4) to be responsible under the Squad Leader's direction for supervising the unloading and reloading of equipment at an incident; and (5) to keep a log of all movements of the rescue truck, including the date, mileage, destination, activities, and time of leaving the Depot and of returning to it.

RECRUITMENT

The recruitment of Rescue Squad personnel is a responsibility of the local Chief of Rescue Service which may be detailed to deputies. The personnel is best recruited through the local Civilian Defense Volunteer Office or by direct appeals to business organizations and industries employing men suitable for rescue work. It is suggested that the executive heads of responsible corporations or business establishments be invited to designate recruiting agents for the men in their employ.

RESCUE SQUAD DEPOTS

Rescue Squads are stationed at Rescue Depots, the locations of which vary according to local needs. Depots should have facilities for housing members of the Rescue Squad when on duty, and their equipment and transport. Depots may be shared with other civilian defense services. Ambulances of the Emergency Medical Service may be based at such Depots.

Three squads of 10 men each, or 30 persons, are considered the full complement of 1 Rescue Depot. This allows 3 shifts which may rotate during periods of heavy duty. Local conditions such as the size and type of buildings in the area and the proportion constructed of brick, stone, concrete, steel, and wood will determine the location, the staff, and the amount of equipment required at the Depot.

Experience has demonstrated that it is unwise to locate Rescue Depots housing costly equipment in an area where they are likely to suffer destruction in the event of a concentrated air raid. Equipment and personnel distributed in the less densely settled outskirts of the city can be moved quickly to stricken points in the heart of the city as needed.

In establishing a Rescue Depot, provision should be made for storing, inspecting, and repairing equipment. A competent member of the Squad should be held responsible for maintaining equipment in good condition, and he should be required to make systematic inspections and tests. A dated record should be kept of the inspections.

DEPOT OVERSEER

Each Rescue Depot should be under the charge of a Depot Overseer, a Squad Leader designated as overseer by the Chief of Rescue Service. He will be responsible for supervision of the Depot and will maintain rosters and inventories, arrange training schedules and squad rotation (on call) and report to the Chief of Rescue Service on Depot activities.

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CHAPTER III

Functions and Operation of Rescue Service

FUNCTIONS OF THE RESCUE SERVICE

The functions of the Rescue Service are:

1. To release living persons trapped beneath debris or in damaged buildings which are not on fire.
2. To render emergency field care to such persons and to transport them to an ambulance or to a safe place nearby.
3. To maintain close coordination with the ambulances and Mobile Medical Teams of the Emergency Medical Service so that serious casualties recovered from debris may have immediate clearance to hospitals and minor casualties to Casualty Stations.
4. To recover the bodies of people killed in collapsed or damaged buildings.
5. To take any immediate steps necessary for the demolition or *temporary* support of damaged structures the collapse of which may endanger life, or hinder the work of the Squad itself or of other services.

Normally, Rescue Squads are not expected to undertake extensive demolition or shoring during rescue operations. These operations will require the aid of local departments of government or private construction or demolition companies, which are organized under the Demolition and Clearance Unit of the Citizens Defense Corps. They can be called through the Chief of the Emergency Public Works Service to assist the Rescue Service whenever heavy equipment and its operators are required. When rescue operations involve much handling of debris and the use of equipment such as wheelbarrows, baskets or buckets, unskilled assistance may be recruited at the site or obtained from the Control Center.

Members of the Rescue Squads may be called upon in an emergency to do related work when this does not interfere with essential rescue operations. They may be called upon:

1. To secure access to essential foodstuffs or supplies immobilized in damaged stores.
2. To secure access to trapped animals.
3. To clear away debris during the post-raid or post-disaster period.
4. To assist Decontamination Squads after a gas attack.

Although the repair of utility services is the responsibility of the Emergency Utilities Service, members of the Rescue Squads should know how to cut off supplies of water, gas, and electricity from damaged buildings if utility repair crews are not available.

In addition to the rescue of persons who are trapped by fire, the Fire Service will deal with the rescue of persons trapped by extensive flooding that requires the use of large pumping facilities, or trapped in upper stories of buildings which can be reached only by long ladders.

When Rescue Squads are available at major incidents, Stretcher Teams of the Emergency Medical Service are not ordinarily required. Upon request of the Rescue Service, they may, however, be dispatched from hospitals and Casualty Stations to assist Rescue Squads at major incidents and will then serve under the Rescue Squad Leader at the site. Stretcher Teams may also be dispatched to minor incidents where the services of a Rescue Squad are not required.

Whether a Mobile Medical Team is sent to an incident by the Chief of Emergency Medical Service depends on the nature of the incident and the number of casualties. As a rule, the rescue workers render most of the first aid to trapped casualties at air raid incidents. Rescue Squad personnel must therefore be thoroughly trained in first aid.

OPERATION OF THE RESCUE SERVICE

The *control* of the work of a Rescue Squad at an incident or practice exercise is vested in the Leader of the Squad. He is responsible for the supervision of the work of his Squad until he is relieved by order of his chief.

When an Air Raid Warden reports an incident with trapped casualties to the Control Center, an Express Party is, through coordinated action of the Chiefs of the Rescue and Emergency Medical Services, immediately dispatched to the incident. It consists of one Rescue Squad, one Mobile Medical Team (a doctor, a nurse, and two or more auxiliaries), one ambulance, and one passenger car or station wagon.

When the Rescue Squad arrives on the scene, the Leader confers with the Incident Officer, the Warden, or police officer in charge, who directs him where to park his vehicle so that it will not interfere with other arriving units. The Leader of the Rescue Squad makes a detailed reconnaissance of the demolished buildings and plans the work. He then assigns the members of his squad to the job of extricating the trapped persons and instructs them how to proceed. If additional assistance is required, the Incident Officer communicates with the Control Center. A detailed outline of the various steps of reconnaissance and rescue work will be found in chapters XI to XVIII.

PART II

Rescue Equipment

CHAPTER IV

Recommended Equipment

A certain minimum amount of equipment is essential for a Rescue Squad. It will be difficult to supply all Rescue Depots in the target areas with the following list of essential equipment, much of which is obtainable locally only in limited amounts. It is, therefore, important that the location of obtainable equipment be known, and for this purpose an inventory of local resources should be made by the local Chief of Rescue Service.

Light trucks (open or panel body), station wagons, and open trailers are needed for the transportation of personnel and equipment, and should be obtained through the Transport Officer of the Citizens Defense Corps.

SQUAD EQUIPMENT

In organizing the Rescue Service, Chiefs should secure the cooperation of Federal, State, and local governmental agencies, other Civilian Defense units, military establishments, and private industrial and construction companies in the pooling of equipment in order to provide adequate amounts. (See table 1, page 29 for list of equipment that may be available in various industries.)

Following is a list of equipment recommended for a Rescue Squad:

1 truck (2½- to 5-ton type).
1 set of tackle blocks (3 sheaves, 2 sheaves).
1 single sheave snatch block.
1 30-cwt. lifting tackle.
1 6-foot chain (3-ton lift).
1 6-foot chain (2-ton lift).
2 6-foot chains (15-cwt. lift).
1 100-foot length ⅝-inch wire rope, thimbles and shackle.
2 50-foot lengths ⅝-inch wire rope, thimbles and shackle.

6 15-foot lengths 1-inch wire rope (scaffold lashing).
1 100-foot length 3-inch manila or sisal rope.
1 200-foot length 3-inch manila or sisal rope.
7 40-foot lengths 1½-inch manila or sisal lashing line.
2 jacks with 10- or 15-ton lift.
2 ironshod levers (10- or 12-foot).
3 pinch bars (or crowbars) with samson.
1 35-foot ladder (extension 2-piece).
1 ladder (8- to 10-foot).
9 pointed shovels or blunt-pronged forks.
2 short handled shovels.
4 debris baskets or buckets.
3 sledge hammers, with pair steel wedges (12-inch) and tongs.
4 picks or mattocks.
1 heavy axe.
6 hand axes (with blade guards).
1 cross-cut saw.
2 hand saws.
1 chain saw.
1 two-edged pruning saw.
1 claw hammer.
1 club hammer (3 pounds).
1 wooden mallet.
1 pincers.
3 cold chisels (8-, 12-, 18-inch), ¾-inch blade.
1 hacksaw (13-inch) with 12 blades.
1 pipe cutter.
2 Stillson wrenches.
1 water shut-off key wrench.
1 gas turn-off wrench.
1 carpenter's brace.
2 bits of ¾-inch and 2-inch center, or wood augers of similar dimensions.
1 flooring awl.
2 wood chisels (¾-inch, 1-inch).
1 marking gauge.
1 set square (10½-inch).
1 turnscrew.
1 oil stone.
2 road wedges (18-inch by 1¾-inch).
1 slate ripper.
2 wheelbarrows.
3 scaffold poles.
2 water buckets (12-quart).
1 stirrup hand pump.
Supply of puddled clay for stopping utility gas leaks.
Supply of timber dogs, spikes, nails.
2 pairs rubber insulating gloves.
2 sets self-contained oxygen breathing apparatus.
2 hose masks.
1 permissible flame safety lamp.
1 charging unit for permissible storage battery cap or hand lamps.
1 carbon monoxide indicator (hand operated type).

1 permissible combustible-gas detector (electric type).
1 geophone.
1 batteryless telephone set complete.
1 reel supplied with enough rope to serve as a life-line.
4 stretchers.
8 blankets.
1 40-foot length of ¼-inch rope (for lashing casualty to stretcher).

Certain additional items may be provided as a depot set of heavy equipment, including heavier lifting tackle, chains and jacks, and (where needed) a portable oxyacetylene cutting outfit with asbestos blanket and goggles. It is desirable to have available an Air-Mover (utilizing compressed air) and a small gasoline-driven air compressor (90 cfm or more) to provide ventilation for clearing quarters filled with gas or smoke.

Some incidents of a major character may necessitate swift removal of massive lumps of brickwork and masonry, dragging away masses of tangled trusses, girders, and other debris, rapid cutting up of portions of reinforced concrete and their removal to facilitate rescue and allow access to trapped casualties. Chiefs of Rescue Service should, therefore, compile a record of such heavy equipment as lifting gear, portable derricks, winches, mechanical excavators, lengths of heavy chain, and other heavy gear available from industry in the community.

INDIVIDUAL EQUIPMENT

Following is a list of equipment that is considered necessary for each member of the Rescue Squad:

1 helmet.
1 pair protective goggles with case.
1 suit coveralls (working type).
1 waterproof cape.
1 beret.
1 pair leather shoes or boots (hard-toed).
1 civilian gas mask (CWS) (issued by Office of Civilian Defense).
1 suit protective clothing (issued by Office of Civilian Defense).
1 pair heavy leather gloves.
1 dust respirator.
1 individual first-aid pouch (issued by Office of Civilian Defense).

The following articles will be needed frequently and may be issued to each member of the shift on duty:

1 clasp knife.
1 permissible electric cap or hand lamp (storage battery type).
1 permissible 3-cell flashlight.
1 extra 3-cell dry battery for flashlights.
2 eyeshields (for use with oxyacetylene equipment, etc.).
1 All-Service gas mask (approved by the U. S. Bureau of Mines for use in gas-air mixtures, commonly encountered in industry, fires, and explosions).

SPECIAL EQUIPMENT

Some of the equipment given in the foregoing lists, such as respiratory protective devices and explosion preventive apparatus, can be classed as special equipment, the use and care of which are out of the ordinary and must be learned through instruction by experts skilled in their use. Detailed description of such equipment is therefore omitted in this handbook and references are given to authoritative publications (page 31).

CHAPTER V

Respiratory Protective Equipment

Civilian gas masks, gas masks of other types, "hose masks," and self-contained oxygen breathing apparatus are essential types of respiratory equipment for rescue work.

The devices for individual respiratory protection from air contaminants other than war gases vary in the degree of protection which they provide. The Bureau of Mines has prepared specifications that embody the performance requirements that a device must meet in order to be considered safe for prescribed purposes. For respiratory protection against nonwar gases only those devices should be employed that bear the approval certificate of the Bureau of Mines.

GAS MASKS

Gas masks consist of a full mask facepiece and a canister which is either connected by a flexible breathing tube and carried on the chest or the back of the wearer (fig. 1) or is attached directly to the facepiece (civilian mask). The gases or vapors against which a particular canister will give protection depend on the chemical content of the canister.

CIVILIAN GAS MASKS

The civilian gas masks are manufactured under the supervision of the Chemical Warfare Service. They are procured and issued by the Office of Civilian Defense for protection against war gases. Rescue workers should carry these gas masks when on active duty, should learn how to put them on properly and quickly, and should use them *only* when war gas is present.

INDUSTRIAL GAS MASKS

Since the Rescue Squad worker is concerned with a variety of emergency situations, *it is imperative* that, if canister gas masks are used, only that type be employed which gives protection against the gas that is present. The All-Service or type N is the *only* gas mask approved by the Bureau of Mines for protection in air against all common gases, combination types, and smokes. Each canister has a limited active life of 2 hours. Such masks are in the possession of gas and other utility companies of most communities.

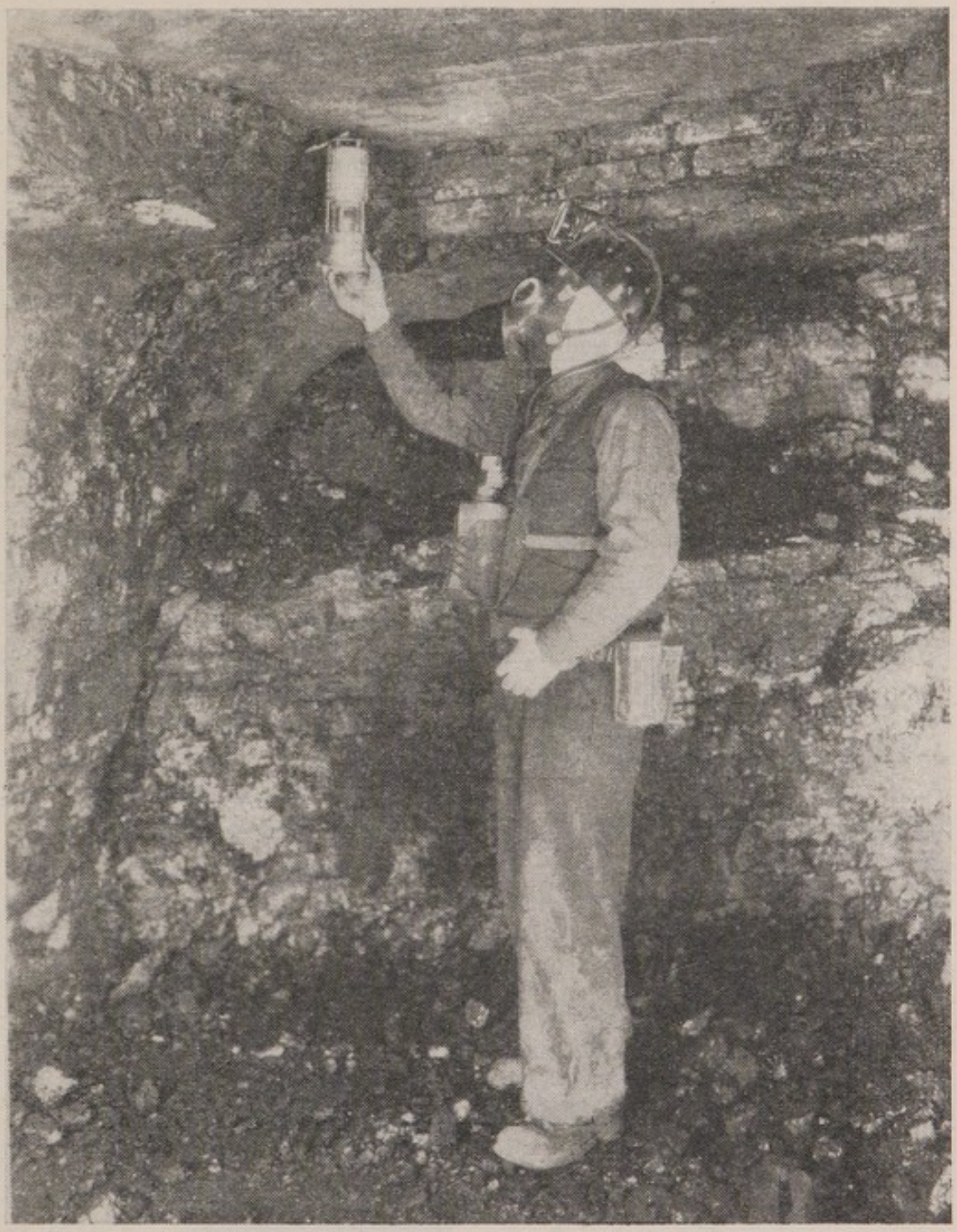

FIGURE 1.—Miner wearing "all-service" gas mask and testing with flame safety lamp for methane gas and oxygen deficiency.

Gas masks are merely air purifiers. They do not supply oxygen and will not protect the wearer against oxygen deficiency such as may occur in closed spaces where the oxygen content is reduced by fire or other means. A gas mask should *never be worn* where a flame safety lamp will not burn.

There is a limit to the concentration of toxic gases and vapors which mask canisters will safely remove. All-Service gas masks are

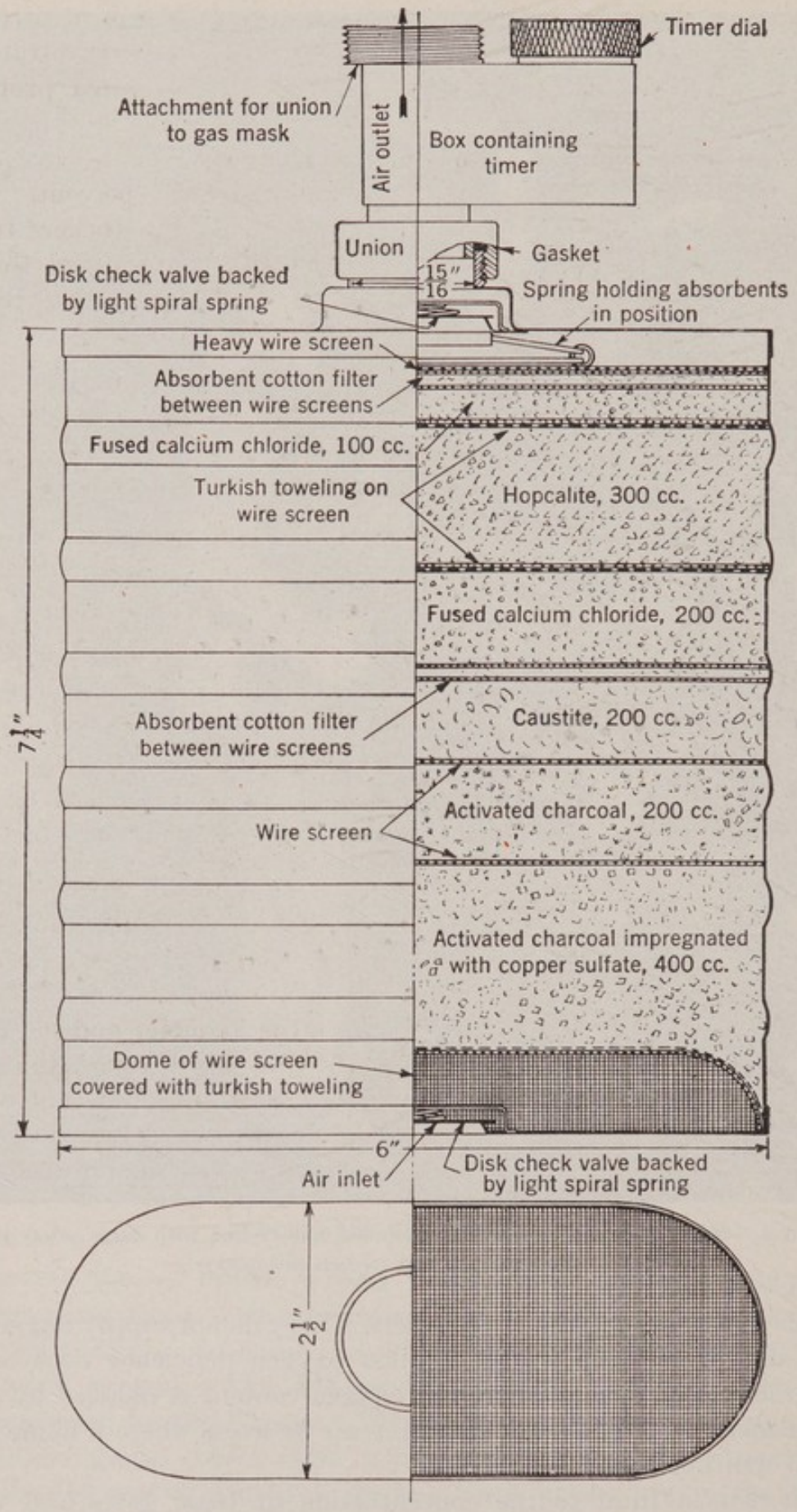

FIGURE 2.—Details of canister for "all-service" gas mask.

not safe in atmospheres that contain more than 2 percent of carbon monoxide, 1 percent of hydrogen sulfide, or a total concentration of toxic gases of more than 2 percent. They give limited protection against ammonia concentration as high as 3 percent, but should not be used where petroleum vapors are present. They do not protect against carbon dioxide in concentrations of over 3 percent. Masks should be worn in dangerous atmospheres only by workers trained in their use, and then only when it has been determined that the composition of the atmosphere is such that the mask will give adequate protection.

HOSE MASKS

The "hose mask" (figs. 3 and 4), or "remote breathing apparatus," as it is called in Great Britain, has been widely used there for rescue work. It furnishes a continuous flow of outside air, and it is a simple and safe protector for use in special situations (high concentrations of carbon monoxide, petroleum vapors, and low oxygen concentration) where a canister mask is unsafe and where the wearer need not go farther than 150 feet from the fresh air. It is also useful to protect the wearer from inhalation of dust while tunneling under debris.

The maximum length of hose approved by the Bureau of Mines for use with "hose masks" is *150 feet for masks equipped with a blower and 75 feet when no blower is used.*

The common type "hose mask" with blower, used in the United States, consists of a tight-fitting, full-mask facepiece, a noncollapsible hose line of comparatively large diameter, a hand-operated blower at the intake, and a sturdy harness that serves the dual purpose of providing a means for anchoring the hose line to the wearer and as a safety belt for attaching a life line for retrieving the wearer in event of trouble. The hose line is of a large diameter and the blower is designed to permit the wearer to breathe air through the device without difficulty or distress, even though the blower is not operating. This unobstructed air passage provides a safety feature in the event operation of the blower is interrupted during use of the appliance.

A "hose mask" with a blower gives complete respiratory protection from all gases, vapors, dusts, fumes, smokes, mists, or atmospheres. It is the only "*supplied air type*" *of respirator* that is approved by the Bureau of Mines for protection from immediately harmful atmospheres. It is the safest equipment for work in confined spaces where petroleum vapors are involved.

"Hose masks" that have the approval of the Bureau of Mines are available in one-man units and in multiple or gang units (fig. 4).

A respirator canister which gives protection against war gases can be inserted in the hose line. It will, however, afford only respiratory and eye protection; protective clothing is necessary for protection of the skin against vesicants.

FIGURE 3.—Hose mask and blower.

SELF-CONTAINED BREATHING APPARATUS

The self-contained oxygen breathing apparatus (figs. 5 and 6), commonly called "mine rescue apparatus," and still improperly referred to as an "oxygen helmet," is the only type of apparatus that

permits the wearer to work at considerable distances from fresh air with complete freedom of travel. It is a heavy and complex apparatus, however, and workers require adequate instruction and practice in its use before they can safely wear it in dangerous atmospheres.

The primary field for self-contained oxygen breathing apparatus is for work in situations where high concentrations of gases or marked deficiencies of oxygen exist which preclude the use of canister masks.

Oxygen breathing apparatus will not provide adequate protection to the wearer under the following conditions:

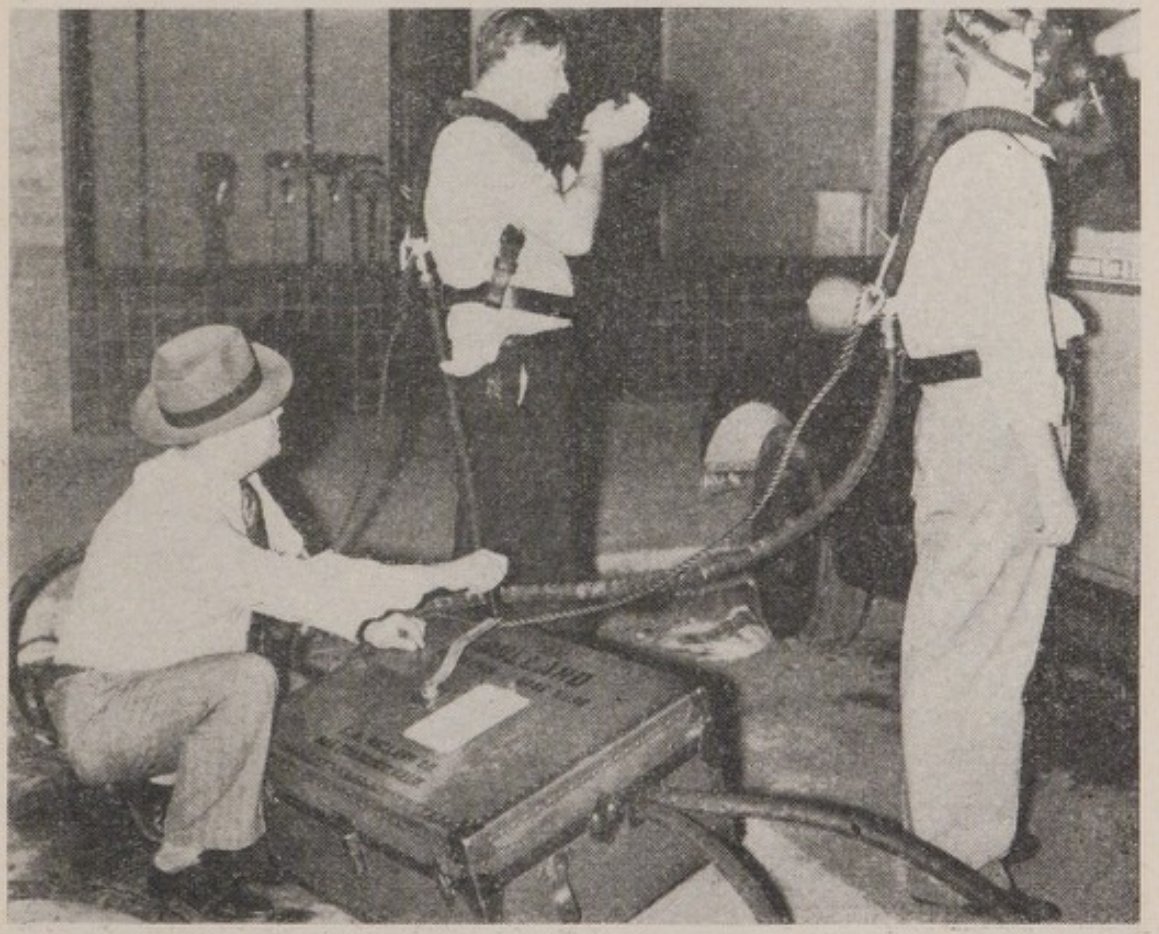

FIGURE 4.—Two-man hose mask showing blower in readiness to be operated. Life line attached to both wearers.

1. Atmospheres containing gases, dusts, or mists that will injure the skin or that may be absorbed through the skin in toxic amounts. High concentrations of ammonia will injure the skin, and hydrogen cyanide will be absorbed through it.

2. Petroleum vapors that will permeate the rubber parts of the apparatus. Some apparatus can be worn only a few minutes (10 to 15) until gasoline vapors enter the breathing bag; others can be worn one 2-hour period, but none can be worn over a prolonged period or successive periods.

3. Abnormal air pressure. It is dangerous to wear oxygen breathing apparatus in air at much above normal atmospheric pressure (14.7 pounds per square inch). A few tests indicate that serious symptoms occur in about 30 minutes when oxygen breathing apparatus is worn in air pressures of about 36 pounds per square inch.

FIGURE 5.—A 2-hour oxygen breathing apparatus.

CARE OF RESPIRATORY PROTECTIVE APPARATUS

A protector must be properly used and maintained in safe condition if it is to afford satisfactory protection. There is no time to make repairs after the need for the equipment arises. In an emergency attempts will invariably be made to use equipment regardless of its condition, and serious or fatal results are almost certain to follow if it is defective.

Respiratory protective devices, especially the facepieces, mouthpieces, and rubber tubing involved in the breathing tract, should be sterilized before a used mask is worn by another person. These parts should be cleaned at the end of each day of use by the same wearer and should be sterilized weekly.

FIGURE 6.—A 1-hour (back-type) oxygen breathing apparatus. A type to be worn in front is also available.

All metal and rubber parts (especially those that come in contact with the skin) should be scrubbed both inside and out with soap and lukewarm water to remove dust, dirt, oil, grease, and perspiration; then rinsed thoroughly and dried.

The procedure for sterilizing equipment depends on the materials of which it is constructed. The proper procedure for a particular device should be decided after consultation with the manufacturer. In cleaning any canister type respirator, great care must be exercised to keep water and disinfectant out of the canister.

CHAPTER VI

Lighting, Gas Detection, and Ventilating Equipment

PERMISSIBLE EQUIPMENT

Permissible equipment comprises protective devices, such as gas masks, self-contained oxygen breathing apparatus, electric cap lamps and flashlights, flame safety lamps, gas detectors and indicators, which have been tested by the U. S. Bureau of Mines in irrespirable, poisonous, or explosive atmospheres, and have been rated as safe for use under the conditions specified on the permissibility plate, which must be attached to each complete piece of equipment.

PERMISSIBLE ELECTRIC CAP LAMPS

Every rescue worker on shift should be provided with a permissible-type storage-battery lamp, preferably the cap-lamp type (fig. 7). It provides *full freedom of the wearer's hands* and for this reason is preferable to any type of flashlight. Electric cap lamps are in use by workmen in the mining and in the heavy construction industries.

These lamps are particularly desirable for Rescue Squads because they provide safety with maximum illumination in any atmosphere; they eliminate hazards from explosions. They remove the possibility of starting fires in broken, splintered, frame buildings or other combustible materials; there is little probability of the wearer's dropping his lamp at a critical moment. These lamps can be used in all kinds of weather, require little attention, and give excellent illumination for 10 to 12 hours before recharging of the battery is necessary.

If flashlights are used by the Rescue Squad for any purpose they should be of a permissible type (fig. 8). Ordinary flashlights are dangerous if used around flammable liquids or in flammable gas-air mixtures.

PERMISSIBLE FLAME SAFETY LAMP

A flame safety lamp is a simple and reliable device for detecting oxygen deficiency. No one should remain in an atmosphere in which the safety lamp will not burn unless equipped with a "hose mask" or a self-contained oxygen breathing apparatus.

FIGURE 7.—Permissible Electric Cap Lamps with Protective Cap.

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Each Rescue Squad should be equipped with a permissible flame safety lamp (fig. 9), and all members of the Squad should be instructed in its dangers and use. Flame safety lamps are used in mines for two purposes: (1) testing for methane gas, and (2) testing for oxygen deficiency. Rescue Squads will rarely use them except in testing for oxygen deficiency. Flame safety lamps must not be used in testing for utility gas unless it is known that only pure natural gas is distributed in the community. Utility gas ("coal" or water gas), which contains hydrogen, may explode in the presence of the flame safety lamp, and since it contains carbon monoxide, may asphyxiate the unprotected worker before the lamp will indicate its presence. The lamp is also unsafe in the presence of petroleum vapors.

FIGURE 8.—Permissible Flashlights.

A flame safety lamp is dangerous in a flammable gas-air mixture unless properly assembled and used. It should always be carefully inspected by a competent person before being used. No attempt must be made to continue use of the lamp after it has indicated the presence of flammable gas. If not removed, it will eventually over-heat and cause an explosion.

COMBUSTIBLE-GAS DETECTOR

The combustible gases likely to be encountered by the members of the Rescue Squad are those constituting the household-gas supply. The only reliable device for detecting explosive mixtures is the combustible-gas detector (fig. 10). Although such detectors are useful in indicating dangerous percentages of combustible gases and vapors of all types, they do not differentiate toxic gases and do not disclose a deficiency of oxygen. The combustible-gas content of an atmosphere can be quickly and reliably determined by their proper use, and the Rescue Squad members should be taught their use, care and limitations.

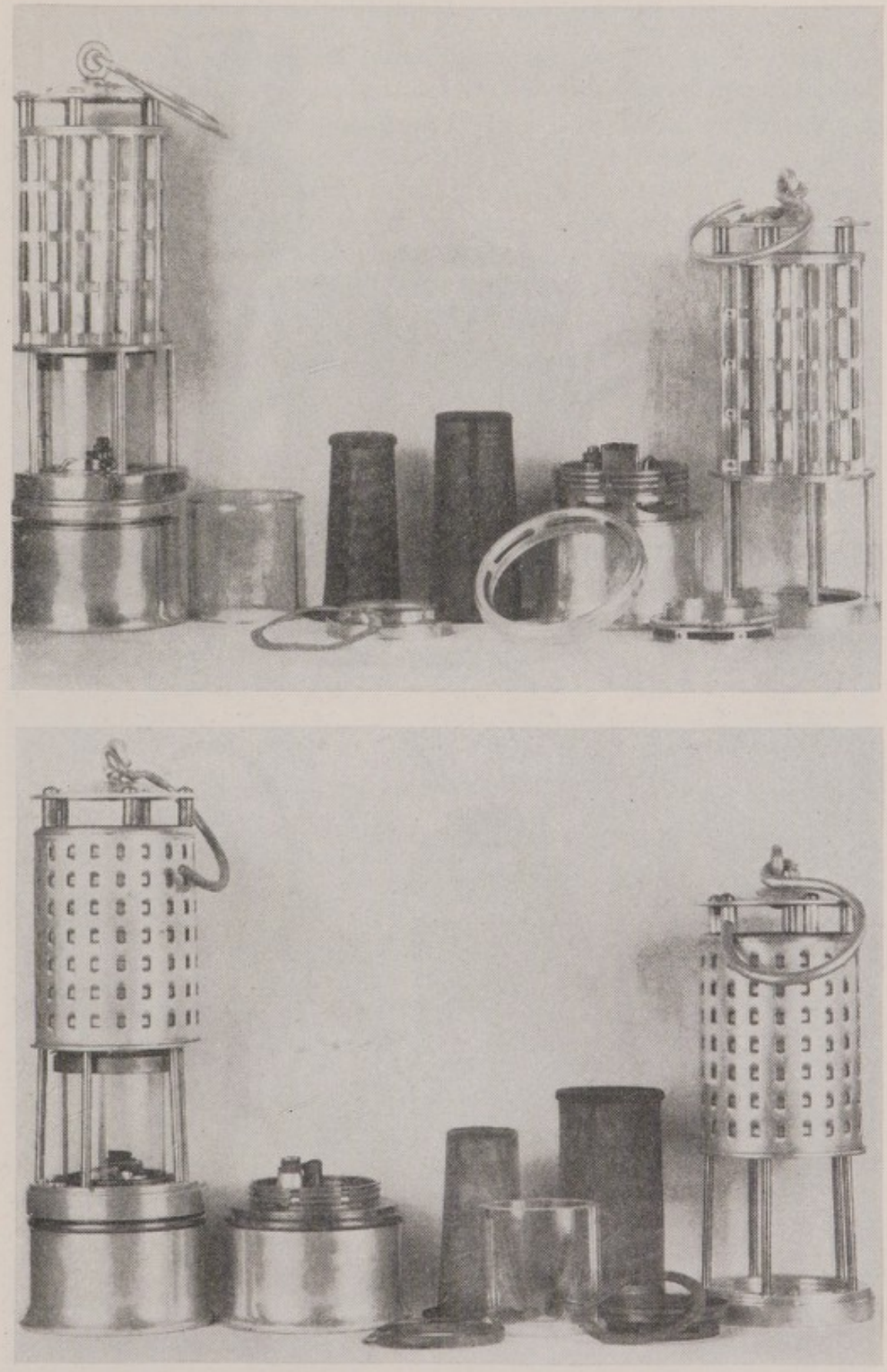

FIGURE 9.—Assembled and disassembled flame safety lamps.

FIGURE 10.—Combustible-gas detectors.

CARBON MONOXIDE INDICATOR

The sense of smell is not reliable for warning against the dangers of utility gases, particularly those which contain carbon monoxide. The carbon monoxide indicator (fig. 11) is a sensitive instrument for detecting low concentrations of carbon monoxide and should always be used by the Rescue Squad unless only *pure* natural gas is used in the community. It can accurately determine low concentrations of carbon monoxide which can be tolerated for a time. This permits work to be done safely in otherwise questionable atmospheres, and saves valuable time.

It is also a valuable instrument for locating gas leaks when household or utility gas contains carbon monoxide. It will not operate in the presence of any other gas but is reactive to petroleum vapors. Its readings are, therefore, not reliable where petroleum vapors are present.

FIGURE 11.—Carbon monoxide indicator (hand-type) calibrated to register carbon monoxide concentrations within the range of 0.005 to 0.15 percent.

INDUCED VENTILATION APPARATUS

Induced ventilation is the most effective method of dealing with common gas hazards, if it can be utilized. It may be the only way of saving persons trapped under debris in the presence of escaping gas. Induced ventilation can clear dead air spaces, trenches, tunnels, etc., so that workers need not be hampered by individual protective equipment.

Compressed Air

The simplest means of induced ventilation is a jet of compressed air from a tank or a mechanical compressor. High-velocity air from an open nozzle or hose will stir up considerable dust, and the jet must be modified in some way. Placing the end of the hose or nozzle in a tin can and tying the assembly in an empty bag will considerably reduce the dust hazard.

Air-Movers

The supply of free air delivered by a given compressor can be increased about 10 times by use of a device known as the Air-Mover (fig. 12). Free air is sucked in by the compressed-air jet at the intake end and blown from the mouth of the expander tube. A few lengths of flexoid tubing can be added to direct the fresh air to the desired locations. The danger of stirring up dust is removed, and a greatly increased volume of fresh air is furnished.

Figure 12.—Improvised ventilation. Use of flexoid tubing in connection with air-mover. Tubing being extended to working face by workman (underground) using oxygen-breathing apparatus.

CHAPTER VII

Survey of Respiratory Protective and Explosion Preventive Equipment

On account of the scarcity of the types of respiratory protective and explosion preventive equipment which may be required by Rescue Squads and the limited number of available men who are trained and qualified to operate or use these devices, a survey of the equipment available locally should be made by the Chief of Rescue Service and a list of such equipment giving its type and location should be posted in each Rescue Depot and furnished to all Squad Leaders.

In general, the industries and utilities listed in table 1 should be canvassed for specified items of equipment.

TABLE 1.—*Rescue Equipment Available by Industries and Utilities*

Respiratory Protective, Explosion Preventive Equipment—Protective Clothing	Industrial and Utility Companies									
	Utilities	Manufacturing	Construction	Iron-steel	Mining	Public safety	Chemical	Petroleum	Shipyards	Transportation
Gas Detecting, Indicating, and Recording Instruments	x	x	x	x	x	.....	x	x	x	x
Canister and Hose Masks	x	x	x	x	.....	.....	x	x	x	.....
All-Service Gas Masks	x	x	x	x	x	x	.....	.....	x	.....
All-Service Gas Masks and Telephone Mask	.....	.....	.....	.....	x	x	.....	.....	.....	.....
Oxygen Breathing Apparatus	x	.....	x	x	x	x	x	.....	x	.....
Self Rescuers	.....	.....	.....	.....	x	.....	.....	.....	.....	.....
Dust and Airline Respirators	.....	x	x	x	x	.....	.....	x	.....	x
Dust Respirators	x	x	x	x	x	.....	x	x	x	x
Paint Respirators	.....	x	x	x	.....	.....	.....	x	.....	x
Metal Fume Respirators	.....	x	x	x	.....	.....	.....	x	.....	.....
Inhalators	x	x	.....	x	x	x	x	x	x	.....
Artificial Respiration Trainers	x	.....	.....	x	x	x	x	x	x	.....
Air Movers	x	x	x	.....	x	.....	.....	x	x	.....
Welders' Protective Equipment	x	x	x	x	x	.....	x	.....	x	x
Goggles and Eyeshields	x	x	x	x	x	x	x	x	x	x
Fire Blankets	.....	x	.....	.....	.....	.....	x	x	x	.....
Safety Belts and Steel Safety Tail Lines	x	.....	x	x	.....	.....	x	x	.....	.....
Ear Defenders	.....	x	x	.....	.....	.....	.....	.....	.....	x
Protective Hats	x	x	x	x	x	x	x	x	x	.....
Safety Clothing	x	x	x	x	x	.....	x	x	.....	.....
Safety Belts	x	x	x	x	x	.....	.....	.....	.....	.....
Electric Cap Lamps	x	.....	x	.....	x	x	x	x	.....	.....
Electric Hand Lamps	.....	.....	x	.....	x	x	x	x	.....	.....
Electric Flood Lamps	x	.....	x	.....	x	x	.....	x	x	.....

In preparing a record of such equipment the following form of questionnaire may be used for obtaining the necessary data:

QUESTIONNAIRE

Equipment and Personnel

1. Name of company or organization_____
2. Address_____
3. How many sets of self-contained oxygen breathing apparatus do you have in safe workable condition?_____
4. How much cardoxide and oxygen do you have on hand?_____
5. Where is your apparatus located?_____
6. How many trained apparatus men are available in your organization?_____
7. How many All-Service gas masks do you have in safe workable condition?_____
8. How many spare All-Service gas mask canisters do you have?_____
9. How many trained gas-mask men are available in your organization?_____
10. How many "hose masks" do you have?_____
11. How many carbon monoxide indicators do you have?_____
12. Will you make your protective equipment available in the event of an air-raid emergency?_____
13. Will you make your trained personnel available in the event of an air-raid emergency?_____
14. Will you provide facilities for transporting personnel or equipment or both to the scene of trouble in the event of an air-raid emergency?_____
15. How many permissible flame safety lamps do you have?_____
16. Are your rescue crews equipped with permissible electric cap lamps?_____
17. How many permissible flashlights do you have?_____
18. How many combustible-gas detectors do you have?_____
19. How many compressed-air-driven ventilating devices do you have?_____
20. Give the name, address, and telephone number of the person to whom the request for equipment and personnel should be made_____
_____
21. Please give the following information on all men in your employ trained in the use of all-service gas masks.

Name	*Address*	*Tel. No.*

22. Please give the following information on all men in your employ trained in the use of self-contained oxygen breathing apparatus.

Name	*Address*	*Tel. No.*	*Date of last training*

REFERENCES ON RESPIRATORY PROTECTION AND EXPLOSION PREVENTION

The following references provide detailed information for general guidance on matters relating to respiratory protection and explosion prevention methods and equipment.

Protection Against Gas, U. S. Office of Civilian Defense. (Relates to war gas.)

Use of a Type N Miners' Gas Mask: Miners' Circular 32, Bureau of Mines, 1929, 29 pp.

Procedure for Testing Supplied-Air Respirators for Permissibility, Bureau of Mines Schedule 19A, 1937, 21 pp.

Testing and Design of Respiratory Protective Devices, Bureau of Mines, Inf. Circ. 7086, 1939, 11 pp.

List of Respiratory-Protective Devices Approved by the Bureau of Mines, Inf. Circ. 7030R, 1941, 12 pp.

Rescue Service Manual, Air Raid Precautions Training Manual No. 3, H. M. S. Office, London, 1942, pp. 26–28.

Self-contained Oxygen Breathing Apparatus: A Handbook for Miners, Bureau of Mines, 1941, 234 pp.

Advanced Mine-Rescue Training: Part I—Mine Gases and Methods for Their Detection: Miners' Circular 33, Bureau of Mines, 1938, 82 pp.

Advanced Mine-Rescue Training: Part III—Protection Against Gas Encountered in Mines; Miners' Circular 35, Bureau of Mines, 1937, 52 pp.

Advanced Mine-Rescue Training: Part IV—Procedure in Sealing and Unsealing Mine Fires and in Recovery Operations following Mine Explosions: Miners' Circular 36, Bureau of Mines, 1938, 80 pp.

Gas Masks for Gasoline and Petroleum Vapors: Tech. Paper 348, Bureau of Mines, 1924, p. 5.

Safety at Natural-Gasoline Plants: Tech. Paper 462, Bureau of Mines 1929, 109 pp.

Safety at Petroleum Cracking Plants, Tech. Paper 551, Bureau of Mines 1933, pp. 39–50.

Detection and Measurement of Gases, *Sewage Works Journal*, July 1933, pp. 662–673.

CHAPTER VIII

Special Working Equipment

STRETCHERS

Rescue workers are the first to reach trapped casualties and must be prepared to administer first aid "on the spot" and transport the casualty without causing further injury. Stretchers of various types will be needed, and it will at times be necessary to improvise apparatus for moving a casualty out of cramped quarters. Various types of stretchers and techniques are discussed in the Office of Civilian Defense manual, *Field Care and Transportation of the Injured.*

OXYACETYLENE CUTTING APPARATUS

Rescue Squads are required sometimes to use oxyacetylene cutting apparatus to facilitate the removal of iron or steel girders and other metallic materials which may be obstructing rescue operations. Oxyacetylene cutting must be done by an experienced person who knows how, when, and where to use the equipment. The operation of the apparatus and the handling of the high-pressure cylinders are dangerous in inexpert hands.

The apparatus must be inspected and tested thoroughly for leaks before it is used. Even small leaks may produce dangerous (explosive) concentrations of gas in poorly ventilated places. A hissing sound will denote large leaks, and escaping acetylene may be detected by its odor. Soap suds or saliva may be applied to couplings and joints to detect small leaks or localize larger ones. Reinforced tubes should be specially checked. The cylinders should not be brought into confined spaces.

When fitting gauges to the gas cylinders, do not tighten them by tapping hard with a hammer, as they are very apt to snap off.

There may be a temptation to use the oxygen from a cylinder to replenish the atmospheric oxygen supply in a closed space during rescue operations. This is *never* permissible. Fatal accidents have been caused by the use of oxygen for this purpose. Any open flame may ignite a worker's clothing or other flammable material. The resulting fire will spread with almost explosion-like rapidity if the oxygen content of the atmosphere is but little above that of normal, and such a fire is almost impossible to extinguish.

There are some special precautions to be observed in caring for and using oxyacetylene cutting equipment.

Rubber Hose.—Do not expose to heat, traffic, sparks, oil, or grease. It may be tested for leakages by immersion in water when under working pressure.

Regulators.—Do not expose to knocks, jars, or sudden pressure caused by opening the cylinder valve suddenly. Release the pressure on the control spring when shutting down.

Blowpipe.—Keep clean, but never use oil or grease. To clean the nozzle use a soft copper or brass wire or wooden splinter, never a steel wire. Leakages should be corrected only by experienced personnel. Persistent back firing usually indicates some fault in the blowpipe and requires immediate and expert attention.

General precautions that must be taken by the Rescue Squad when using oxyacetylene cutting equipment are as follows:

Oil or Grease.—Keep oil, grease, and other fatty materials away from the gas cylinders and cutting apparatus. These materials may be set on fire by oxygen under pressure, with consequent possible damage to the equipment and injury to personnel.

Ventilation.—Adequate *ventilation must be provided* during cutting operations.

Fire.—Make sure there are no combustible materials within reach of the sparks made during cutting. Serious fires have occurred when the flame of the torch accidentally cut the supply hose leading from the acetylene cylinder. If the cylinder is at some distance from the point of operations, the confined quarters may become filled with dangerous gases before the gas supply can be cut off. For this reason tanks should be located in the open so that the gas supply can be cut off even if the hose is burned through.

Personal Protection.—Protect the eyes at all times with colored safety goggles.

Support of Object.—Make sure that when the cut is completed the pieces do not fall so as to cause injury to the operator or others.

Protection of Trapped Person.—If cutting has to be done near a trapped person, protect him against sparks, fumes, torch, and glare by asbestos curtains or other means.

Reinforced Concrete.—When cutting reinforcing bars, guard against splinters from surrounding concrete which may be loosened by the intense heat.

RESCUE TRUCK AND TRAILER

Suitable vehicles are a vital part of the Rescue Squad's equipment, for on them depend the prompt transportation of the Squad personnel and equipment to the scene of an incident.

Rescue Squads may be equipped with trucks (open or panel body), station wagons, and open trailers. Each type of vehicle has certain advantages, and it is desirable that each Depot have access to different types.

The covered truck offers best protection to its contents, and lends itself readily to the storage of equipment. Open trucks can be used for removing and carrying debris or special equipment, but must be so fitted that unloading and loading can be accomplished quickly. Dump trucks can be used to great advantage in debris removal and when available should be utilized for this purpose.

A trailer not only provides a means of carrying excess equipment but may be operated in places where it is impossible or undesirable to take a truck.

Each Rescue Squad should maintain a list of the equipment with which it has been furnished, and this list should be used as a basis for checking the equipment at periodic inspections and after incidents. It is recommended that this list be mounted on a board and kept on the truck.

The loading of equipment should not be done in a "slipshod" manner. An efficient system of loading and packing of equipment in the truck should be planned and adhered to:

1. Provide a clear floor space. It is hazardous and unnecessary for men to stand on their equipment when manning the truck.
2. Group the equipment. Delicate or fragile equipment must be protected against damage by personnel or heavy equipment.
3. Let accessibility of each item form the basis of the detailed plan of loading.

Caution.—Heavy items must be adequately secured or rested on the floor of the truck. Serious accidents have occurred to personnel when jacks, for example, became unfastened during a journey.

LIFE LINES AND TELEPHONES

Whenever rescue work involves working inside damaged buildings, through tunnels or under debris, especially if respiratory protective apparatus is required, contact should be maintained between those working in the debris and those assisting in various capacities in fresh air or on the surface. This may be done by means of a rope "life line" or a batteryless portable telephone apparatus which also serves as a "life line." Life lines serve the dual purpose of transmitting warnings and other messages to the worker on the surface, and serving as a guide to the worker's location if the debris collapses behind him and he must himself be rescued. A life line attached to the worker's safety belt may also serve to drag him out of danger if he is overcome by fumes or heat, without risking other workers to go in after him. This

cannot be done, however, for any great distance or around corners without risk of cutting the rope or cable or injuring the subject. Where possible, an unconscious or injured workman should be carried rather than dragged out by a life line.

Sash cord in lengths of 500 feet or more wound on a metal reel serves satisfactorily as a life line. Although such a line has been widely used as a means of transmitting signals, it is far from satisfactory, because it is extremely difficult to transmit signals clearly when the exploring crew is several hundred feet away or has followed twisting passageways.

Life-line signals that are used generally are:

1 pull, "stop" if traveling or "all right" if at rest.

2 pulls, "advance."

3 pulls, "retreat" (from fresh-air base to team, "retreat at once").

4 pulls, "distress."

A life line should be kept taut at all times for the transmission of signals.

Portable telephones (batteryless type) are more efficient and satisfactory than the simple life line. Portable telephones that operate without batteries have been developed so that they can be used effi-

FIGURE 13.—Portable telephone life line unit assembled for use by the apparatus wearer and the listener at the fresh-air base.

ciently and satisfactorily for communication between oxygen breathing apparatus or gas-mask crews and the fresh-air base. Ordinary portable telephone apparatus is unsafe to use in an atmosphere of explosive gas because it may be a source of sparks. The equipment (fig. 13) consists of a receiver attached to a head set and throat transmitter worn by the worker, a light insulated cable wound on a light metal reel, which is suspended and encased in a wooden box and is connected to a combination hand set for use of the man at the fresh-air base. The telephone transmitters are voice-energized and no electric current is used, but it is possible with this equipment to conduct an ordinary conversation satisfactorily through 2,500 feet of cable.

A telephone system of this kind will greatly facilitate the work of crews wearing apparatus where a life line is required, and will enable the man in charge of the fresh-air base to keep in communication with the crews working ahead of fresh air much more efficiently than if an ordinary life line were used. It can also be used to advantage in many situations where respiratory protective equipment is not required.

PART III

Rescue Squad Operations and Control

CHAPTER IX

Action on Air Raid Alarms

Every member of the Rescue Service must thoroughly understand the various air raid warning signals, and the action to be taken when warnings are received or heard.

Revised air raid protection regulations were issued by the Eastern Defense Command on February 17, 1943, and are outlined in Operations Letter No. 107 of the Office of Civilian Defense. These regulations have now been adopted by all States except those in the Western Defense Command and are the basis of the following discussion.

ACTION ON THE ALERT OR "BLUE" WARNING SIGNAL

The warning signal designated as "blue" (long, steady blast on air raid siren, horn, or whistle) is the first public warning, and means "Probability of enemy air raid—Enemy planes appear to be headed in your direction—Get ready." It will precede, when enemy planes are spotted sufficiently in advance, the "red," or immediate danger warning signal (series of short blasts on horns or whistles, warbling notes of siren).

The Rescue Squads which are on call should, in common with other Civilian Defense forces, mobilize immediately on the first audible alarm in order to be prepared to respond instantly to orders from the Chief of Rescue Service at the Control Center. Mobilization of Rescue Squads takes place at the Rescue Depots. Each Depot Overseer must prepare his Depot facilities for immediate action.

Members of Rescue Squads on duty should proceed to their action stations, put on their personal equipment, make necessary preparations for immediate call-out, and await further instructions.

The rescue truck and trailer should be fully loaded and equipped with everything that will be required by the Squad at an incident and the Driver should test the motor to have it in readiness.

The Leader should make an inspection to insure that both men and equipment are in readiness for action. A watch should be posted at the Depot for the detection and control of incendiaries.

ACTION ON "RED" (IMMEDIATE DANGER) SIGNAL

When the "red" warning is sounded, members of the Rescue Squads at their Depots should, if all preparations for action have been completed, take shelter until dispatched to an incident or until receipt of the "All Clear." The Depot Overseer must make certain that the telephone or other communication facilities are manned at all times.

If the "red" warning is sounded without a preliminary "blue," members of Rescue Squads on call at the time must proceed to their Depots despite the risk involved.

ACTION ON "ALL CLEAR"

Rescue Squads are to remain at their Depots prepared for action until relieved by the Chief of Rescue Service.

ACTION ON CALL-OUT (DISPATCH ORDER FROM CONTROL CENTER)

When a call-out is received, the facts are given by the Depot Overseer to the Leader of the Squad on duty. *Written instructions* should be given to the Squad Leader concerning the location of the incident and the route to be followed, together with any information received from the Control Center concerning road conditions or possible sources of special danger either on the route or at the site of the incident.

The Leader should ride beside the Driver, and both must be thoroughly familiar with all traffic and lighting regulations and must adhere strictly to them.

As an air raid develops, it may become necessary to send Rescue Squads from one Control District to another in order to give assistance in heavily raided areas. When such assistance is requested, the requesting district must specify clearly a point where incoming Squads will be met and escorted to incidents or Depots to stand by. A messenger may be detailed by the receiving Control Center to meet the Squad and escort it to its temporary base or the incident at which it is to serve.

As soon as a Squad that has been out on reinforcement returns to its own Depot, the Leader should submit to his Control Center a complete report of all matters pertaining to his Squad and the equipment used by it.

CHAPTER X

Operation and Leadership at Incidents

The Leader directs the Driver to the incident or other specified point, on instruction from the Control Center. The vehicle must be halted in a suitable position near the incident, where it will not block traffic or obstruct other services. The Leader consults the Incident Officer or the Warden or police officer in charge at the incident, concerning the best parking place.

As soon as the truck is parked, the men dismount and line up at the side of the truck to await instructions. The Driver switches off the engine, and mounts the rear of the truck ready to hand out equipment as it is wanted.

INCIDENT CONTROL

At minor incidents (e. g., involving the destruction of a small detached house with few casualties), general control of the situation will usually be exercised by an Incident Officer, or by a Warden or police officer on the spot. At a large or major incident involving considerable damage, many casualties, and the attendance of several services, general control of the situation will usually be exercised by a specially trained Senior Incident Officer, who may be a senior Warden, senior police officer, or other qualified person.

The Incident Officer acts on the scene as the representative of the Commander, but he has no authority in the technical direction of the Rescue Service or other specialist services. His function is to coordinate the efforts of the various services so that relief can be provided in the quickest and most efficient manner, and the incident cleared up in the shortest possible time.

To this end, the Incident Officer establishes an Incident Post near a usable telephone as a center of communications at the scene of damage, and keeps the Control Center fully informed of the situation and of the progress of the work of the various services on the spot. The leader of each service keeps in constant touch with the Incident Officer at the Incident Post and consults him and also the leaders of other services so far as may be necessary to insure the harmonious completion of the work.

During the daytime, the Incident Post is marked by a special flag; at night, it is marked by two red lamps placed one above the other.

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The Incident Officer himself may be distinguished by an arm band bearing the words "Incident Officer" or in some other prescribed way.

When an incident is first reported to the Control Center, it is seldom possible to determine the nature or extent of the damage because the first report has to be made quickly, before extensive examination of the site can be made. For this reason, it is usual to send out an Express Party which includes one Rescue Squad to each incident and to rely on the judgment of the Leader of the Rescue Squad, who accompanies the Party, to call for assistance if he thinks the size of the job is such that it cannot be handled by his Squad alone.

If there is an Incident Officer, the Rescue Squad Leader and other Leaders must cooperate as closely as possible with him. They must keep him fully informed of the strength of their Squads, of the progress of their work, of the steps underway or proposed, and consult him continually on such matters as reinforcement of personnel or equipment, the order in which different operations are to be carried out, and the order in which different services are to proceed with their work.

REPORTING TO INCIDENT OFFICER

When a Rescue Squad arrives at an incident, the first job of the Leader after his vehicle is parked is to go on foot to the man in general control—the Incident Officer, if there is one, otherwise the senior Warden or senior police officer on the spot.

The Leader gives the designation of his Depot or community (if from outside), and asks for instructions and for information concerning:

1. The nature and extent of the damage.
2. Whether persons are trapped and the approximate number.
3. Whether war gas is present and the type (persistent or non-persistent).
4. Whether there are any collapsed buildings or dangerous structures that require immediate attention to safeguard casualties and personnel.
5. Whether there is any other source of danger such as fire, damage to gas, water, and electricity supplies; leakage of utility gas, flooding, or live electric cables or components.
6. Whether the public utility services have been advised of the damage to the service mains, etc., and whether any steps have been taken to cut off the supply of gas, water, and electricity at the mains.
7. Whether there are any unexploded bombs.

If war gas is present, the Leader must at once give full instructions to his men and make certain that they are protected. If persistent

gas is present, protective clothing must be worn, and the Leader must take all necessary steps to see that his men work without rushing, so that they will not become exhausted. Replacements will be necessary at frequent intervals. (See Chapter XVIII, p. 113.)

REINFORCEMENT OF PERSONNEL AND EQUIPMENT

On first approach to a bomb incident, the general tendency of Leaders is to overestimate the amount of damage caused and to be somewhat overwhelmed by the difficulties of rescue. This tendency must be checked, as it may cause Leaders to call for help in excess of requirements and so deplete the strength of the local Squads available for relief or service at other incidents. In general, additional help should not be called for until a complete survey of the damage has been made, and the Leader, in consultation with the Incident Officer, is in a position to decide whether the resources of men and equipment on hand are adequate to cope with the situation.

RELEASE OF SURPLUS PERSONNEL

It follows that any surplus Squad personnel or equipment must be released at the earliest possible moment. Whenever a Leader finds that he can dispense with personnel or equipment, he must immediately advise the Incident Officer so that the Control Center can be informed. The Controller will then inform the Incident Officer whether the Squad released is to return to its Depot or to proceed elsewhere.

COOPERATION WITH OTHER SERVICES

If there is fire, the Leader and his men must act largely under the general direction of the senior officer of the Fire Service at the incident, and must be ready to assist with any rescue equipment they may have available.

Normally, it is the work of the Fire Service to rescue persons trapped in the upper floors of a burning building, or in a flooded cellar or basement. While in the former case Rescue Service ladders may be brought into operation, the rescue of people from flooded basements will probably involve the use of the powerful fire service pumps, unless the Rescue Service has pumps available for this purpose.

The Rescue Squad Leader must not hesitate to call for the assistance of any other service that may be at the scene, e. g., the Fire Service, Police or Wardens. If necessary, he will cooperate with the Incident Officer to recruit assistance from the general public for such purposes as manually handling or wheeling debris, or taking care of people released from bombed premises.

While any willing person may be used for unskilled work, the Rescue Leader should see that no difficult or hazardous rescue operation is undertaken by any but fully trained rescue workers, and that specialized rescue equipment (e. g., heavy lifting tackle) is handled only by competent persons. Although much of the assisting work in connection with rescue operations (such as the removal of the debris, etc.), may be undertaken by any other helpers available, dangerous and difficult work must be done entirely by qualified rescue personnel.

PRIORITY

So far as is necessary for the completion of rescue work at an incident, the Rescue Service normally takes priority of place, movement, and approach over other services except the Fire Service.

Wherever there is fire, the Rescue Leader must cooperate with the leader of the Fire Service so as to decide on operational procedure and see that the Fire Service is given all possible assistance by the rescue men on the spot.

At any one incident, there should be only one Leader in general charge of the rescue operations. Unless arrangements to the contrary have been made by a superior officer, the first Leader to arrive normally takes charge of all Rescue Squads present, and any Leader or Leaders who arrive later should place themselves at his disposal.

When a Rescue Squad from another district is brought in to reinforce a Squad already at work, the reinforcing Leader should report to the Incident Officer, and also to the Leader of the Rescue Squads at the incident, and place himself under the latter's instructions.

Normally, a reinforcing unit will not go into action until such contact is made. But if contact cannot be made, and there is a definite need for additional men and equipment, the reinforcing Squad will not delay going into action.

RECORD OF WORK

The Squad Leader, on completing a period of work at an incident, must record on the proper form the number of injured and dead that have been removed from the buildings, the address of the place where they were found, and the loss of any equipment, etc., and send the report to the local Chief of Rescue Service. In addition, loss of equipment should be reported to the Overseer of the Depot.

In addition, a careful record should be kept of the operations in order that the Leader may be able to hand over the history of the incident to the Leader of a relieving Squad, and thus prevent duplication of work.

Upon completion of the work on the site, the Leader should collect and check his equipment and assemble his men, call the roll,

make a verbal report to the Incident Officer of the work carried out, and await instructions as to any further work to be done or for the Squad's return to the Depot. On returning to the Depot, the Squad will go off duty when relieved by another Squad in the rota or released by the Control Center.

RESCUE SERVICE

SQUAD LEADER'S INCIDENT REPORT

Incident No._____
Report No._____
Date_____

Work done from_____ to _____
Address of Incident:
_____ Depot No._____
_____ Squad No._____
Casualties to Rescue Squad:
_____ Number in Squad_____
_____ Hours worked_____
Equipment Lost or Damaged:
_____ Mileage run_____

Number of Casualties Rescued during above Hours

Condition	Men	Women	Children	Total
Dead				
Injured				
Uninjured				

(Names of casualties when known and location where found must be given on back of this form.)
Brief description of work done by Squad_____
_____
Is job finished? _____ If not, state why Squad left job
_____

Signature of Squad Leader_____

Signature of Chief of Rescue Service (if present) _____

PART IV

Rescue Technique

CHAPTER XI

Damage to Buildings and Other Facilities

British experience has demonstrated that all bombs of a given size have a similar explosive effect; that buildings of the same class and type of construction tend to collapse in much the same way, and that certain common factors are present.

Many buildings in the United States are not constructed entirely of materials that permit classification as strictly frame, brick, stone, or concrete and steel construction. In many critical areas, wooden frame buildings constitute the vast majority of residential buildings. These communities also usually contain apartment houses, schoolhouses, churches, business blocks, and other buildings constructed of materials such as masonry and steel, which present different problems as regards bomb damage.

Considerable damage may be done by a bomb which strikes a building and does not explode. Roof tiles, slates or shingles may be knocked off, chimneys wrecked, walls or partitions cracked, glass broken and even floors brought down.

Where wooden frame buildings are involved, there exists the problem of rescuing people who may have taken refuge in basements. If fire has not occurred, it will be necessary to rescue, from masses of wood and other debris, the casualties who have taken refuge or were caught in floors above the basement.

GENERAL EFFECT OF BOMBS ON BUILDINGS

The subject of damage to buildings from bombs is discussed in detail in the following publications of the Office of Civilian Defense: *Bomb Reconnaissance*, *Report of Bomb Tests on Materials and Structures*, and *Protective Construction*. These publications should be studied by the members of the Rescue Service in connection with exercises and drills for *Individual Training and Squad Training*. (See Part V.)

Experience shows that multi-storied steel and concrete buildings are inherently resistant to the effects of bombing. Wooden frame build-

ings present a fire hazard, but aside from that withstand quite well blast effects produced by bombs outside of the building. In all buildings, however, windows and doors may be blown out and debris may penetrate or be scattered over large areas.

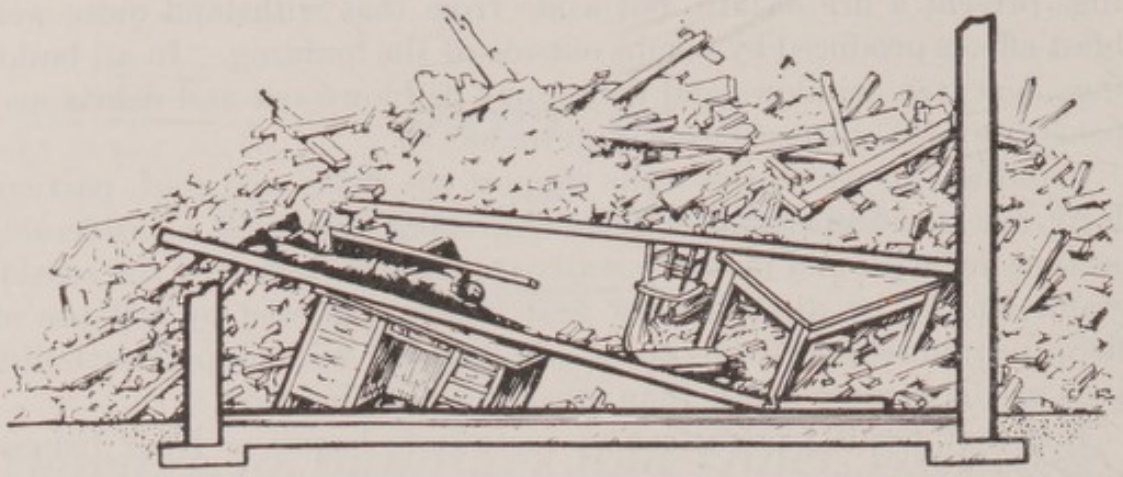
Buildings in which the walls support the floors and roof, particularly brick and masonry, suffer the greatest damage. Considerable sections of brick and masonry walls are readily destroyed for considerable lengths by direct hits or near misses, followed by collapse of floors or roofs supported by them. Collapse of wall-supporting buildings produces more debris than other types of structure.

Fire may result from attack by incendiary bombs or from dislocation and destruction of gas mains by explosive bombs with subsequent ignition of escaping gas. In non-fire-resistant buildings such as wooden frame buildings, the hazard of fire is great. Rescue Squads must not depend upon any assistance from the Fire Service and must understand and practice the principles of fire prevention. They may be required to assist the Fire Service or fight minor fires on their own account.

HOW BUILDINGS COLLAPSE

In any type of construction, when floor supports fail, the floors and roof drop, coming down in one piece, breaking into large sections and forming V shapes, or remaining supported on one side and sagging down on the other in the form of a lean-to (fig. 14).

A wooden floor tends to hold together in one piece, even if distorted and broken in the center, because the floor boards, nailed to fairly heavy floor joists at short intervals, form a strong and flexible "raft." This "raft" can be of great help in rescue operations, because it may have fallen in such a way as to protect casualties underneath it from falling brickwork and rubble, or because a void left underneath it provides a means of rapid access to the interior of the debris pile. Access to the void can be gained either by raising one portion of the collapsed floor and creeping underneath, or by cutting a hole through the floor boards and joists in order to effect entrance. In either case, great care must be taken to see that the work does not upset the stability of the collapsed floor and so cause it to collapse still further and injure any entrapped people or working personnel.



"A" HORIZONTAL OR PANCAKE FLOOR COLLAPSE

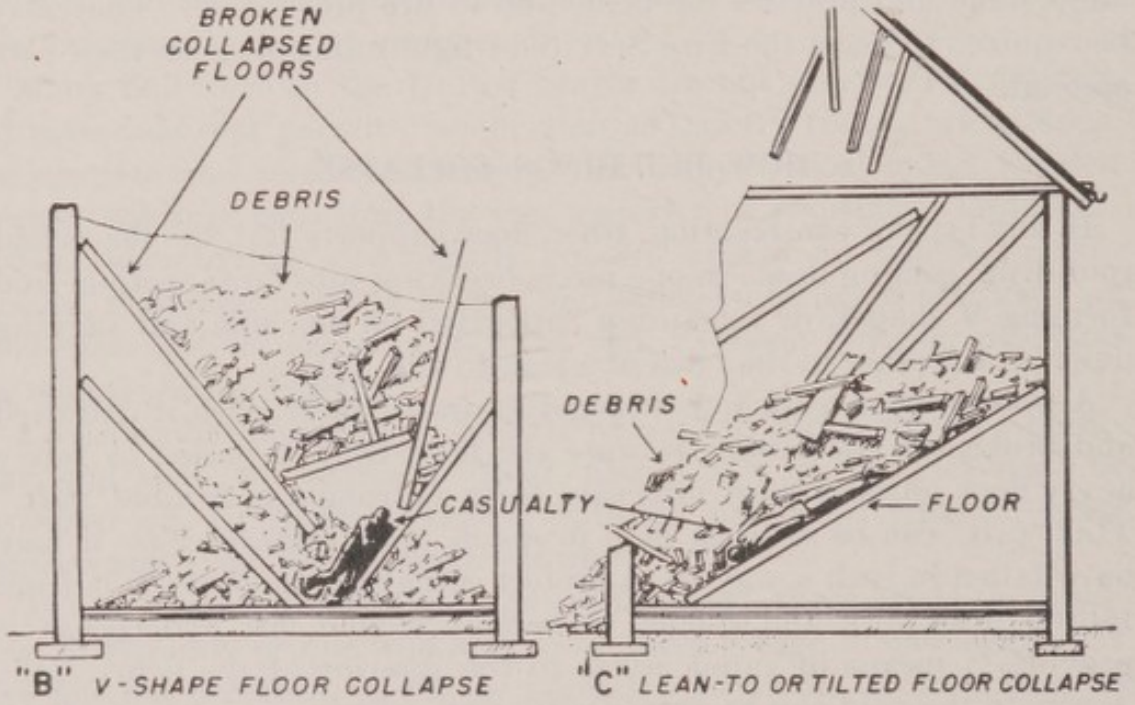


FIGURE 14.—Various types of floor collapse.

COLLAPSE OF BASEMENTS AND FORMATION OF LEAN-TO'S

Although severe damage to basements may result from earth shock, it is unusual for the outside walls of a basement to be completely destroyed, principally because they are below ground level and are, therefore, protected against the full force of the explosion, and because they are normally of much greater thickness than walls above ground.

In row houses, walls that separate one basement from another are usually thinner than the outer walls of basements.

The ceiling of a basement is more likely to be damaged than the walls, because it receives the full load of debris from the upper floors,

even if it does not receive the direct impact of the bomb itself. The result is a partial or complete collapse of the ceiling unless it has been specially strengthened to withstand the load.

In considering where lean-to's are likely to be formed when the joists over a basement have collapsed, it should be remembered that floor or ceiling joists are practically always laid to span the narrower width of a room, so that lean-to's are most likely to be against the longer sides of the room. If the room is square or nearly square, however, only an inspection of the broken floor joists or boards will indicate how the floor has fallen.

In addition to protecting trapped people lean-to's or voids can also be used to gain access to other parts of the basement or to basements in adjoining buildings.

KNOWLEDGE OF LAYOUT OF LOCAL BUILDINGS

It is very difficult to appreciate fully the extent to which a building has been damaged or to decide the best method of undertaking rescue work without some knowledge of the actual form and layout of the buildings involved. In fact, when buildings suffer extensive damage, it is sometimes difficult to identify the different rooms, passages, etc., or even the house itself.

All Leaders and as many Squad members as possible should visit and examine the construction and general lay-out of as many typical buildings in their area as is possible, taking particular note of points that may be of assistance if rescue operations in similar buildings should become necessary. Experience shows that too much reliance should not be placed on information received from the general public or even from former occupants as to the layout of buildings.

Groups of Leaders may well discuss the construction and layout of local buildings, and work out together procedures for rescue of persons if the buildings are damaged in various ways. These procedures should serve as a basis for practice drills.

Squad Leaders should also be familiar with hallways, basements and rooms of buildings used as public or private air raid shelters in the area served by their Depots. The OCD has defined a policy on air raid shelters in Operations Letter No. 130 and in Protection Division Circular No. 18. Establishment of Technical Committees which include architects and construction engineers has also been recommended (Operations Letters Nos. 66 and 94). These committees bring together technical experts who can advise the Commander of the Citizens Defense Corps on safe shelter areas in the buildings of the community. Rescue Squad Leaders may be asked for advice on shelter policy in the course of their advance study of buildings in their areas, but they should give such advice only when authorized to do so by the

Chief of Rescue Service with the full knowledge and approval of the Commander and his Technical Committee, and in accordance with the policies established by them. Air raid wardens are charged with being general advisers on protection matters for the residents of their sectors, and Rescue Squad Leaders should work closely with them in making their observations and rendering advice.

EFFECTS OF BOMBS ON UTILITIES

Water, gas, and electricity are supplied to almost all buildings and are liable, when damaged by high explosive bombs, to cause special complications and dangers in rescue operations.

Units of the Emergency Utilities and Emergency Public Works Services of the Citizens Defense Corps are charged with the responsibility of dealing with such problems. During heavy raids, however, they may not be immediately available when needed. Rescue Squads, therefore, must have sufficient knowledge about the service mains and supply pipes, etc., to enable them to take any urgent measures necessary to minimize risk to life and property and carry out their own work.

Water

Water released from damaged or broken water pipes or water accumulated as a result of fire-fighting activities, may cause the flooding of part of a building below ground level, and the flooding, unless checked quickly, may endanger persons trapped in the basements. Where there is any possibility of this, the Fire, or other Service designated by the Control Center in case the Fire Service is not available should be notified through the Incident Officer to pump out the water or to endeavor to keep down its level until the trapped persons can be rescued. However, Rescue Squad Leaders should know the locations of all portable pumps in the district and obtain them through the Control Center according to prearranged plans.

If the valves controlling the supply of water to premises can be found, flooding can be prevented or arrested by closing them. If the service valve cannot be located, the flow of water may be stopped by driving wooden plugs into the ends of the service pipes.

If there is a secondary water supply from a storage tank situated at the top of the building, the valve controlling this supply also must be turned off. This valve will usually be found near the supply tank. Supplies from boilers and heating systems are usually controlled by a valve near the boiler or hot water tank.

In large buildings, it is desirable for the boiler-man to shut down the heating system when an air raid warning is sounded.

When water is running into basements from outside sources, such as damaged mains in the street, an attempt should be made to divert the flow either by constructing a rough dam with sandbags or other available material or by digging trenches and forming channels.

Utility Gas

When a building is damaged, gas mains and pipes are usually broken and there is consequently considerable escape of gas. In addition to being highly inflammable, utility gas, when mixed with air, will explode violently if ignited. *Hence, no lighted cigarettes or naked light of any kind should be taken near a damaged building until it is definitely known that there is no escape of gas.*

Whenever there is a smell of gas at an incident, the first step is to inform the Emergency Utilities Service at the Control Center through the Incident Officer or Warden and to take special precautions against fire or explosion. If the Rescue Squad has respiratory protective apparatus, some attempt should be made to locate and stop the escape. At the same time, the valve controlling the main supply should be found, if possible, and the supply turned off.

Details of how to proceed in the presence of utility gas are described in Chapter XVII.

Electricity

In the great majority of bombed buildings, the electrical installations are so badly damaged that the main fuses are blown and the whole circuit rendered harmless. Care must always be taken, however, to avoid touching any cables, electrical tubing, fittings, etc., until the supply has been definitely cut off, or the installation is known to be dead.

Every installation is controlled by at least one main switch. When electricity is used for power as well as lighting, there may be two main switches, one for each supply. If there is more than one tenant in a building, there may be a separate switch for each tenant. Main switches are placed as near as possible to the point where the supply cable enters the building. They are usually oblong or square metal boxes with an iron handle on one side. Usually the "on" and "off" positions are clearly marked on the box. Rubber gloves (or some other form of insulation, e. g., a dry blanket) should be worn on the hand when touching a switch, as the switch may be "alive" if it has been damaged. Even after the main switch has been turned off, the cable from the switch to the road outside may still be alive.

If lamps within a building fail to light when the ordinary light switch is on, it should not be assumed that the current is cut off.

Failure of the light may be due to broken filaments in the lamps or to blown fuses.

Fires caused by electric cables should be extinguished with dry sand or earth, not with water or fire extinguishers.

Electrical cables, wires, switches, etc., should not be interfered with if gas is present; even the movement of a switch may cause a spark sufficient to ignite the gas.

Many factories and large buildings have their own transformer substations. The substation is usually in the basement of a building with its entrance always marked by a special "Danger" notice. These substations, as well as any other electrical plant, motors, switchgear, overhead cables, etc., should not be touched until some authorized person has rendered them harmless. (See Electrical Hazards in Air Raids, Appendix D.)

Sewers

Fractures, shattering, and cave-ins of sewers can result from bombing. Such damage may create hazards by the damming back of sewage, with flooding of basements, or by the escape of certain gases in dangerous concentrations.

Serious damage to sewers should be reported immediately to the Control Center. Before assistance from the Emergency Utilities Service reaches the incident, Rescue Squads should, if possible, prevent flooding of basements where casualties are trapped by diverting the flow of sewage either by trenching or construction of temporary dams. If this is not possible, the Fire Service may be called upon through the Incident Officer for equipment to pump out flooded areas where casualties may be trapped. Where damage to smaller sewers occurs, it may be possible to prevent flooding by plugging the fractured pipes.

If gas is escaping from the damaged sewers, care must be taken in confined areas to avoid the dangers of concentrations of gas, according to methods described elsewhere (Chapter XVII).

CHAPTER XII

Rescue by Stages and Location of Casualties

Most rescue operations have to be conducted under conditions of great difficulty and confusion, often made worse by darkness. As a result, it is usually very difficult to form a true picture of the problem at an incident, and it is, therefore, highly important that rescue operations should be carried out systematically, in stages, and by a definite plan.

On first approach to a large incident, even the most experienced tend to be overwhelmed by the appalling confusion, and by the magnitude and apparent impossibility of the job. This mental reaction is quite natural. And it is at such times that a Leader must exercise all his qualities of coolness, perseverance, and courage, and make full use of the knowledge gained in his previous experience and training.

At the same time, the Squad, to avoid harassing the Leader, must display confidence in him and must help him especially by remembering:

1. Not to ask unnecessary questions.
2. To give the Leader advice *only* when he asks for it, otherwise to remain silent.
3. To listen attentively, so that instructions need be given only once.
4. To keep together on the job, and not to be missing when needed.
5. To concentrate on the job at hand and not to be concerned with other people or other services; that is the Leader's duty.

RESCUE BY STAGES

Rules cannot be devised to give Leaders complete and sure guidance as to how to tackle every job. But, if work proceeds in stages according to a regular plan, important points are less likely to be overlooked, the problems of the incident will be more correctly determined and appropriate planning made easier.

It is suggested, therefore, that every rescue operation should proceed, as nearly as possible, by the following successive stages. These are arranged so as to be *generally* applicable to any job, from start to finish of the work, and are easily memorized by reference to the key headings:

Stage 1. Reconnaissance.—General survey of damaged building. Collecting information from Incident Officer, Wardens, and others as to the whereabouts of casualties and the layout of the building. Systematic calling and listening for casualties. Assessing complicating factors such as utility gas, war gases, flooding, dangers from overhanging walls, etc.

Stage 2. Immediate Rescue.—Rescuing victims who can be seen or heard or whose exact location is known from available information.

Stage 3. Exploration.—Searching strong or sheltered parts of the building which are likely to have withstood the blast (e. g., air raid shelters, staircase cupboards, basements, etc.), even though there is no information that anyone is trapped there.

Stage 4. Selected Debris Removal.—Removing debris from selected places where casualties of uncertain whereabouts may be found, having regard to the information available at the site coupled with a careful study of the way in which the building has collapsed.

Stage 5. General Debris Clearance.—If people are still missing, systematically stripping the site of all debris without preference for any particular areas (as in Stage 4).

Whether or not information as to the whereabouts of victims is available from the Incident Officer, Wardens, police or members of the general public at the incident, the first four stages as set out above should always be completed. Where persons are still missing, Stage 5 must also be carried out before the rescue operations are finally discontinued.

Where operations are prolonged, relieving Squads must be fully informed as to progress made and areas searched, and Squads must not leave the incident until relief Squads arrive.

RECONNAISSANCE AND IMMEDIATE RESCUE

Reconnaissance (Stage 1) should always be undertaken before later stages are begun. If, however, any victims can be heard calling or are obviously only partly or lightly buried, they should be extricated at once while the Leader completes his survey of the damage and collects all available information. Clearly, Stage 2 (Immediate Rescue) requires the most urgent effort. As many men as possible should be set to work on immediate rescue, and no other work should be undertaken until this stage is completed unless a large number of men are available.

Where no person can be heard calling and no information is available as to the definite whereabouts of any people trapped, Stage 2 cannot be carried out. The next step, therefore, is Stage 3. This stage may be carried on simultaneously with Stage 4, but it should never be omitted, for, even if Wardens and others think it unlikely

that people are trapped in the places where the Leader considers there is the best chance of life, they may be wrong. In fact, experience shows that information received at the site is often unreliable and misleading, and, while due regard should be paid to apparently reliable information of a positive kind, Rescue Squads should beware of accepting unverified statements about the absence of victims.

Collecting Information

The best method for determining the whereabouts of trapped persons or ascertaining whether or not there are any victims in a damaged building is to make careful inquiry from local people. This normally is the duty of the police and Wardens, who, in addition to making inquiries, usually have their own records to consult. *If no Warden or policeman is available at the incident*, the Rescue Leader must delegate one of his own men to make inquiries of people nearby; if necessary, he must make such inquiries himself.

Every effort should be made, not only to obtain as much useful information from local people as possible, but also to check any information that is received. Even if a person has the best of intentions, his information may be wrong, especially if he is highly excited or anxious about missing relatives or friends.

The following methods may also yield valuable information, especially at a large incident involving a number of victims:

1. Check hospital lists for number of persons already accounted for.
2. Question casualties or trapped persons moved from the damaged premises, as they are the persons most likely to know the number and whereabouts of people in the building at the time of bombing. To this end, visit casualties at Casualty Stations and hospitals, if necessary.
3. Visit nearby Rest Centers and collect information from any persons who normally live near the incident.
4. Check mortuary lists, as persons being sought may have already been extricated and identified.

In flats, hotels, etc., it is usually possible to ascertain only the total number of persons normally resident in the building, and not how many were actually in the building at the time of the incident, or where they were at that time. In such cases, therefore, it is safest to assume, to begin with, that all the persons normally resident in the building were present at the time of the incident, and, as various residents who were out turn up at the site, their names should be taken and the number of missing persons reduced accordingly. Experience shows that if this is done systematically and if every absent resident who turns up is carefully questioned, a fairly accurate estimate can

usually be obtained within 24 hours of the number of persons still in the building.

Calling to Victims

Leaders who have to determine the whereabouts of persons trapped in a damaged building or buried under debris will find it a good plan, on first reaching the incident, to station men in various locations and to direct everyone to keep quiet for a few moments. Experience shows that even weak cries or groans can usually be heard when this is done.

In addition to listening in this way, rescuers should call out to victims and, where persons may be trapped behind a wall, should tap on the wall in some distinctive manner and then place the ear against the wall to listen for sounds. Such tapping and calling is, however, of little use unless silence is maintained by the service personnel and others.

In locating trapped people, a geophone has been successfully used at mine disasters. A geophone is a simple instrument, the construction and uses of which are described in the following publications of the U. S. Bureau of Mines: Report of Investigations No. 2102; Technical Papers Nos. 277 and 433; and Bulletin 178.

When communication of this kind has once been established with a person, it should be continually maintained as far as possible because:

1. It keeps up his morale; it helps him to withstand whatever pain and discomfort he may be suffering, and may even keep him alive.
2. It helps rescuers to work in the right direction—sometimes a difficult matter in the dark.
3. The victim, if sufficiently conscious, may be able to give warning of any displacement or movement in the debris likely to cause him further injury.

Conversation with a trapped person should always be of a reassuring nature, making light of the extrication work, and encouraging him to talk about his own work, his friends, or anything that will relieve his mind, rather than about his position or injuries.

EXPLORATION OF LIKELY PLACES

Stage 3 of a rescue operation—searching strong or sheltered parts of a building *even though no definite information is available that any persons are trapped in such places*—does not mean that every possible hole and corner of a building should be searched for victims (see Stages 4 and 5), but that *likely* places should be looked for and fully explored. The essential purpose is to recover living casualties by exploring places which would have afforded any persons who might have been there a reasonable chance of survival. The exact places thus

explored must depend to a large extent upon the type of incident, the extent of the damage, and whether or not an alarm was given, but the following are typical places that should be searched:

1. Specially constructed air raid shelters, inside or outside the building.
2. Spaces and closets under staircases.
3. Basements, cellars, coal holes, etc.
4. Points near fireplaces and chimneys.
5. Voids and spaces under floors that have not entirely collapsed.
6. Rooms which have not been entirely demolished but from which exit is barred by debris.

In the last instance the trapped persons can usually be heard calling and, therefore, will probably be attended to under Stage 2, before the general exploration of likely places is begun.

Too much stress cannot be laid on the need for searching likely places for victims who may still be alive and of effecting their speedy release *before* any attempt is made to rescue victims with much less chance of survival; but the ideal procedure is, of course, to carry out both tasks simultaneously, if that is possible.

Before deciding which of several victims should first be rescued, the position of each victim and the work involved in his rescue should be considered in relation to the position of the others and the difficulty of extricating them.

SELECTED DEBRIS REMOVAL

Experience shows that, having regard to various circumstances, people whose whereabouts in a building at the time of bombing were not definitely known are nevertheless more likely to be found in some parts of the debris than in others, and early rescue is more likely if the debris is first attacked at carefully selected points.

If, for example, there is information that a certain person was last seen on an upper floor and is reasonably thought to have been there when the bomb dropped, efforts to discover that person might proceed as follows:

First.—If possible, get some idea how the floor, on which the victim was supposed to be, has fallen and where it is lying.

Second.—If the floor has completely collapsed and fallen in a more or less horizontal position at the bottom of the building, clear as much of the floor as possible, since the victim may have gone straight down with the floor and may still be on it.

Third.—If the floor has broken in the center and formed a rough V shape with a considerable amount of debris piled on top, the victim may have slid down into the bottom of the V between the broken ends of the floor.

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Fourth.—If the floor has held at one side and fallen or sagged at the other, the victim may have slid down and may be trapped under the debris at the lower or sagging end of the floor.

If the victim is known or thought to have been in bed at the time of the incident, the recovery of the bed or bedding may give some additional indication as to his whereabouts. Search should be made both under and around the bed, as the force of the explosion may have blown the casualty out of bed, although in such a case the bedding is likely to be still around or near the casualty and will, therefore, serve as a guide.

Chimneys and staircases on outer walls are usually the strongest parts of a building and consequently suffer least damage from blast. Also, walls whose *edges* face the direction of the blast are usually much less affected than walls that directly face the bomb. Any victims sheltered by such parts of a building may, therefore, be still alive.

DIRECT HIT

When a building receives a direct hit, victims and parts of the structure may be thrown a considerable distance, though casualties are not likely to be found beyond the range to which debris has been thrown, or very far removed from the debris. Some instances are known in which bodies have been blown from a building receiving a direct hit, onto the roofs of two- or three-story buildings some distance away. The maximum distance to which a human body is likely to be blown is about 300 feet, and the maximum height about 60 feet.

Bodies are frequently found at the bottom of a bomb crater. This is apparently due to the ease with which a human body will roll down a slope as compared with debris, which tends to stick. Experience also shows that casualties may be recovered alive from the earth thrown up around a bomb crater. In such a case the casualty is apparently saved from the main blast of the bomb by the earth thrown up and also by the upward direction given to the blast by the sides of the crater.

In larger buildings, a direct hit may or may not cause a crater, though this will depend on the size of the bomb and on the height and construction of the building. In general, the debris resulting from a direct hit is more widely distributed and more broken up, while the various floors, etc., are more difficult to identify than is the case with a near miss.

FIELD CARE OF CASUALTIES

To assist with subsequent identification, an Emergency Medical Service Casualty Identification Tag should be attached to every serious or unconscious casualty or body located, stating the exact spot where the casualty or body was found, etc.

The Rescue Squad is expected to give emergency first aid and to move casualties to a place of safety where they will receive further attention or from which they can be taken to a Casualty Station or hospital. If a doctor is available, his advice should be sought as soon as access has been made to a trapped casualty. Initial medical treatment can then be given, and advice be obtained as to how the casualty should be approached and extricated.

PRECAUTIONS ON ENTERING DAMAGED BUILDINGS

Many dangers are likely to confront men who have to enter a building immediately after it has been damaged. Actually, rescue men tend to ignore danger to themselves in their eagerness to save others. Although many rescue operations are effectively carried on only by a disregard of a certain amount of danger, and while personal courage and readiness to face danger are to be encouraged and commended, rescue men must also take necessary precautions to avoid personal injury. A rescuer who is injured places a double strain on his fellows; he not only reduces the number of rescue men available to help others, but also increases the number of casualties to be handled at the incident.

Rescue personnel should, as far as practicable, observe the following safety rules:

1. Always wear a steel helmet or other proper head protection.
2. Never touch loose electric wires or cables; they may be alive.
3. Be on the alert for utility gas. It may be poisonous, and if a spark is introduced, it may cause an explosion. Do not depend upon the sense of smell; use the proper gas-testing device at all times.
4. Wear the proper respiratory protective equipment when working in gassy atmospheres. Civilian gas masks do not afford protection against utility gas.
5. Ventilate a gassy space as soon as possible.
6. Always walk as close to a wall as possible unless it is known to be dangerous.
7. Do not go into dangerous or unknown places without a companion to help in case of accident.
8. Use a life line when going into dangerous places.
9. Use permissible electric cap lamps for illumination, and never use open lights or smokers' articles in atmospheres where utility gas, refrigerant gases, broken wood, or other combustible materials are present.
10. Make safe all walls or piles of debris that are dangerous and likely to fall or slide and produce injury.

USE OF LIGHTS DURING THE BLACKOUT

One of the greatest difficulties of night rescue operations is the restriction on the use of lights imposed by the risk of attracting the attention of enemy bombers. When rescue operations are being conducted near burning buildings, therefore, the fullest possible advantage should be taken of the situation to get a good look at the surroundings before the fire is extinguished.

Good general lighting for a small incident can be obtained, without breaking the blackout regulations, by parking Civilian Defense vehicles in such a manner that their masked headlights shine on the rescue site. If there is difficulty in arranging the vehicles in this manner, use should be made of cap lamps, flashlights or other officially authorized lights.

CHAPTER XIII

Rescue by Clearance of Debris

NECESSITY FOR DEBRIS CLEARANCE

If no information is available as to the approximate whereabouts of persons believed to be trapped, the removal of debris is necessary in order to explore places where persons may be buried (Stage 4 of Rescue Procedure), even though their chances of being alive may appear remote or nonexistent.

There is an essential difference between debris clearance as a means of rescue and the removal of debris to clear a site. The former is a complicated and difficult task that must be done rapidly but with extreme care, whereas the latter can be done by mechanical means, and time, cost and procedure are governed by considerations other than rescue problems.

Insofar as the work of the Rescue Service is concerned, the job of clearing away debris at an incident is limited to clearance for the purpose of rescuing trapped persons or bodies.

METHODS OF DEBRIS CLEARANCE

In general, there are two methods by which people trapped under a pile of debris may be recovered:

1. By removing the debris piece by piece in such a manner as to uncover the trapped persons and release them safely.

2. By trenching, burrowing, or tunneling into the debris so as to make a safe passageway through which the trapped casualty may be reached and rescued. Methods of tunneling debris are discussed in Chapter XIV.

In both these operations a very important principle must be borne in mind. If anyone survives at all inside or under a large pile of debris after a building has collapsed, usually it is because some heavy timber, floor or other portion of the structure has fallen or remained fixed in such a way as to protect the survivor from the main impact and weight of the debris. The support may be very unstable, and unless great care is exercised, it may collapse before the victims whom it is protecting can be extricated. Internal collapse can be avoided only by *disturbing the debris as little as possible during rescue operations* and by making sure that, as one portion of the debris is removed, the remainder is not dislodged and allowed to slide or fall in.

Care in this regard makes for saving of life in two ways: first, by minimizing the risk of further injury to trapped persons, including possible suffocation by dust; and, second, by making for greater speed in the rescue operation, because the less debris that has to be handled, the less work there is to be done in effecting the rescue.

The decision of how little debris shall be removed to achieve rapid extrication is one which must be left to the Leader. There are situations where the removal of the smallest possible amount of debris may not necessarily be the most rapid method of releasing the trapped person. Thus, it may be far quicker in the long run, to move a heap of debris than to cut through a girder. Such factors as the accessibility of the debris to be removed, the number of men available for work, the nature of the debris, etc., all have an important bearing on the question of how quickly the job can be done.

Whereas speed is unquestionably a most important factor in all rescue operations, speed without safety to both the rescuer and victims may defeat its own ends. *The ideal is speed with safety.*

Debris can be cleared or removed with standard rescue equipment to a vehicle or dump by:

1. Removing by hand, loading into and carrying the debris in baskets or buckets.
2. Loading into and transporting by wheelbarrows.
3. Loading into baskets or other containers and hoisting clear of the site by derrick.

Stripping operations should be carried on simultaneously at as many points as practicable. A series of lanes may be made through the debris followed by sideways clearing from these lanes, or a straight working face may be carried through from an open side. The debris should be dumped away from the demolished building, on adjoining land, part of a street or other available place, avoiding obstruction to necessary traffic. The practice of "turning over" debris in the search for bodies should be avoided whenever possible, as it usually leads only to confusion and duplication of work.

Considerable dust may be raised when the debris is moved and although the rescue workers can and should protect themselves by wearing "dust respirators," the trapped casualty cannot have such protection, and may be suffocated by dust unless precautions are taken. When the removal of the debris is likely to create considerable dust that will be troublesome or hazardous to anyone, it should be wetted down.

Rescue Squads should be well equipped for their job, but very often only the simplest tools can be employed in the earlier stages of debris removal. Often hands, suitably protected by gloves, are the safest.

It may be necessary to lift "rafts" or large sections of the debris by means of jacks, and then creep underneath to recover the trapped persons; or it may be better to cut a hole in a floor to gain access. Cutting tools must be used carefully in order to avoid further injury to trapped persons who may be lying close to the point at which access is being made. Debris in the immediate vicinity of a casualty, or close to a place where a victim is likely to be, should, if possible, be removed by hand. It is sometimes very difficult to recognize a body in a pile of debris, particularly after a fire or where large quantities of dust are present.

LIGHTING DURING DEBRIS CLEARANCE

So long as there is a reasonable chance of recovering casualties or bodies by debris clearance, the work must be continued by the Rescue Squads, even at night.

If there are no blackout restrictions, floodlighting can prove invaluable. However, the use of electric cap lamps will avoid shadows and provide safe illumination for each man as he proceeds with his work, when other illumination is insufficient, unsafe, or unavailable. All lighting must be within the limits of blackout restrictions imposed by the military or Civilian Defense authorities.

PRECAUTIONS IN DEBRIS CLEARANCE

The portion of the debris providing a shelter or an air pocket for trapped persons may be very unstable. The degree of stability of the mass must be estimated and the approach made carefully so as to insure that the rescue operations do not disturb the loose materials. No one should be permitted to climb about on top of a pile of debris during clearing operations. The slightest movement of the debris load or of the supports may cause further collapse with serious consequences to casualties and rescue personnel and may place beyond hope people who otherwise have a good chance of survival.

As the debris is removed there is danger that materials previously supported by the debris may slide into the field of operations. Sides of excavations or the working fronts of the pile of debris should be shored and braced where necessary, especially where there is pressure from the pile of debris itself or from adjacent damaged walls or buildings. Adjacent buildings or walls should be braced in order that there will be no danger of walls settling or moving the debris. Platforms, guard rails, scaffolding, and shoring should be erected to protect the rescue workers. (See fig. 15.) In removing a pile of debris a reasonable slope should be maintained in digging, and the pile of debris should not be undermined.

FIGURE 15.—Rescue Squad shoring, bracing, and erecting scaffolding adjacent to pile of debris. Clearance of debris and tunneling work are being done in darkness. Observe rescuers are equipped with individual electric cap lamps, head protection and other standard Rescue Squad equipment. Debris consists largely of timbers, broken concrete and steel members.

Timber or any other piece of material should not be withdrawn from a pile of debris unless it is certain that no injury or danger to persons trapped will result from further collapse.

Risks may have to be taken in raising obstacles by means of jacks or other equipment. These may be supporting many tons of debris and should not be disturbed unless their removal is necessary for the extrication of the casualty.

In the search among debris for missing persons, experience has shown that it is quite common to find small portions of human remains. These should be carefully removed and turned over to the proper authorities, since identification is necessary, if possible, and in addition such evidence may furnish a clue for further exploration.

CHAPTER XIV

Trenching and Tunneling

The removal of large piles of debris in order to recover trapped persons is usually a very slow and laborious process. When the whereabouts of trapped persons are known, therefore, it is often quicker, and in many ways better, to reach them by tunneling under or through the debris so as to disturb the main pile as little as possible. Tunneling cannot be effectively employed on every job. It may be quicker and more efficient to drive a trench through the debris, as where debris blocks entrance to a line of bedrooms along one side of block dwellings.

TRENCHING

Trenching may be done for the purpose of stripping a site of debris (Stage 4 or 5) or for gaining a point of entry for tunneling. If trenching is done for debris clearance, a series of trenches may be driven into or through the debris and the remainder removed from between the trenches. As a trench is driven into a pile of debris and as the pile is entered, it may develop into a burrow or into a tunnel.

Burrowing from a trench is often employed in the early stages of debris removal or after darkness.

The operation of burrowing is commenced by picking out the larger pieces of timber or other materials from the face nearest the objective and then by hand-picking, shoveling, and gradually working into the pile of debris while removing a minimum amount of materials to complete the rescue.

In many particulars, trench construction is more dangerous than tunneling. Particular attention should be given to shoring the sides, and progress must be governed by the nature of the debris. A worker in the trench has little chance of avoiding injury in event of the collapse of the trench or a slide of debris. Whenever such sources of danger are present, the sides of all trenches should be secured by the use of sheet piling which should be adequately braced.

The size of a trench will depend on the purpose for which it is being driven—i. e., for debris clearance or for entry to a tunnel—and on the nature of the materials composing the debris.

In trenches from 4 to 7 feet in depth, wooden sheet piling should not be less than 2 inches thick, and when over 7 feet in depth, not less than 3 inches in thickness.

The bracing and shoring of trenches should be carried along with the excavation and should in no case be omitted in rescue work when trapped casualties are involved. Of course, if Stage 5 is under way and no trapped live casualties are involved and if a mechanical digger is used, the shoring may be placed as close to the lower end of the boom as possible. The braces and trenches should be supported by screw jacks or by timbers placed at right angles to both braces, cleated and rigidly screwed or wedged.

The excavated material in rescue operations should not be placed near the edge of the trench, but at some location where it will not be necessary to search it again if people are still missing after the trenching operation.

TUNNELING

Tunneling should not be aimless. Unlike debris clearance, which may reveal the presence of casualties in all kinds of unexpected places, tunneling is of little use for making a general search for casualties whose whereabouts are not known. *Tunneling is essentially a technique for reaching a specified spot.* This should be either the place where a person is *known* to be trapped (Stage 2), or some void underneath the debris from which further exploration of likely places (Stage 3) can be undertaken once an entry has been made. As a general rule, tunneling should be carried out from the lowest possible level.

For night operations, when lights must be restricted, tunneling is of particular value and should be tried whenever indicated.

Tunneling may at times be the safest and most practical way to remove a pile of debris as the final step in clearing the site (Stage 5) or even in searching for victims (Stage 4). Debris can thus be removed from the bottom in slices or by running loose materials into the tunnel for removal when a very large pile of debris is involved. A tunnel affords protection against walls which may fall on the pile of debris. Although tunneling is of questionable value for making a general search for casualties whose whereabouts are not known, there are occasions when large piles of debris could not be safely or quickly removed and explored without the use of tunnels.

In tunneling, the interior of a pile of debris may be found in such an unstable condition that the removal of a comparatively small piece of timber or other obstacle may cause considerable movement. A careful watch must, therefore, be kept for key pieces of this kind, and whenever possible, they should not be disturbed. So as to avoid accidental movement, these key pieces should be secured in position by fixing a prop or other timber under them in such a way as to leave a free passage for a man to continue the work. Recognition of these key pieces is, however, not always possible, and, in such conditions,

the only safe procedure is to timber and brace everything in the tunnel as the work proceeds. Time spent in this way will not be wasted. It will not only prevent accidents and possible injury to the rescue personnel, but also avoid the considerable delay bound to arise if the tunnel collapses and has to be started all over again.

Material for timbering and lining the inside of a debris tunnel can usually be found at the incident, the timber from the damaged building being cut to lengths as required. This is not always possible, however, and an inventory should be made of all timber or lumber supply in the neighborhood of the Depot in order that Rescue Squads may quickly avail themselves of this source of supply if necessary. Poor lumber should never be used where lives are involved.

The shape and form of debris tunnels is so irregular as to make it impossible to follow any definite scheme of timbering such as can be applied in tunnels driven in the earth. There are, however, two chief methods of carrying out this work, either or both of which can be employed as the nature of the work demands:

Method 1. Use of Simple Props or Stulls with Cap Pieces.—The method of using props or stulls with cap pieces is adaptable when the load is not too heavy and the materials to be supported consist of large pieces of debris such as timbers, boards, collapsed wooden floors, heavy or firmly wedged pieces of concrete or other masonry, etc. It is essential to remember that props should be provided with cap pieces which must be wedged solidly into place and braced if necessary so that they cannot slip or become loose and fall out if there is any movement in the materials supported. It may be necessary to put a sill beneath a prop, and wedge the sill securely in place; or it may be possible to hitch the bottom of the prop into the floor. Loose materials should not be placed around the foot of a prop to hold it in place. Props should be set to support their maximum load and so placed as to avoid obstructing the use of the tunnel for foot-

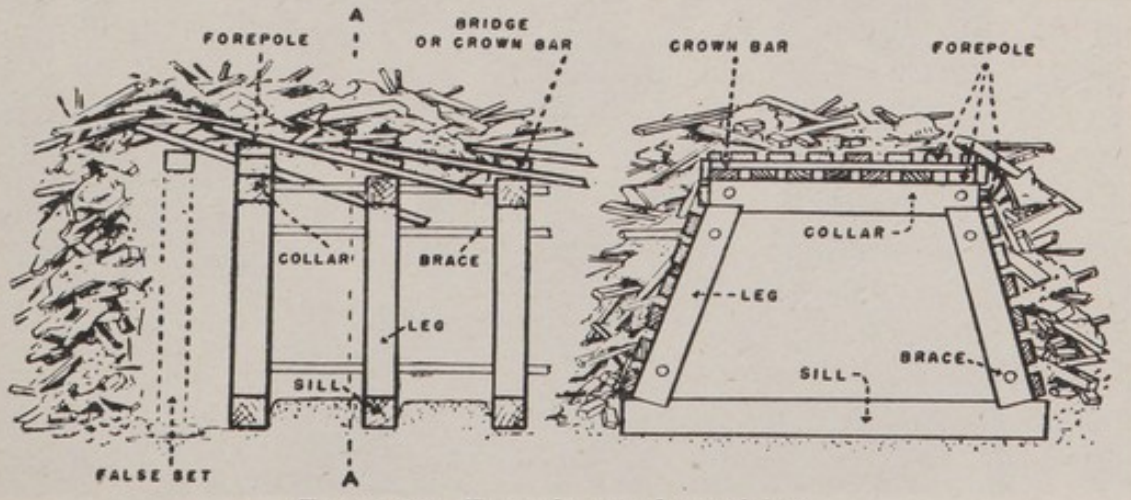


FIGURE 16.—Forepoling in loose debris.

travel, for moving the debris from the face, and for removing casualties.

Method 2. The Use of Sets and Forepoling.—The use of sets and forepoling is a method of timbering employed in driving a tunnel through loose debris that cannot be held by means of props and cap pieces; also where a heavy load must be prevented from running or caving into the tunnel.

Figure 16 shows a longitudinal section and a cross section of a tunnel being advanced by forepoling. First, pointed poles or planks are driven a short distance over the top of the last set with a hammer or ram (fig. 17). If the debris is very loose, lagging or side poles are driven ahead practically the same distance. When the planks have been driven ahead 2 or 3 feet beyond the center of the last set, the pressure of the heavy debris may be so great as to threaten to force the planks down by bending or even breaking them. If this is the case, a false set is placed as firmly as possible against the top and side so as to catch the forward end of the partly driven poles or planks, and removal of the excavated materials is continued until enough advance has been made to place the regular set. The top and side forepoles (planks or poles) are then blocked out from the timbers (collar and legs, also called cap and posts) by bridges (crown bars). The false set is then removed, and after the timbers are properly

FIGURE 17.—Driving forepoles in a debris tunnel by use of a ram. Three-piece sets, braced at collar, support heavy loose debris.

spragged (braced) the operation is repeated, and the driving in the face progresses.

Tunneling by means of sets, particularly with sills, is not usually practicable at incidents, as this demands a more or less even cross section of tunnel. However, there may be occasions when it must be done in very heavy loose debris. This necessitates careful work in moving key timbers within the mass of debris. Such an instance is shown in figure 17, where the forepoling on both tops and sides is being driven into place by the rescue workers, using a ram. In such work the workmen need both hands, and the advantage of using electric cap lamps for individual illumination is apparent.

The debris of a demolished building usually includes large quantities of dust and small rubble, which tend to trickle through the timbering of tunnels and shafts. Although this may not at first appear to be of much importance, the escape of the material in quantity may disturb the mass of the debris, and cause further internal movement. The timbering used in tunneling through small rubble or other finely broken material, therefore, should be boarded as closely as possible.

The rectangular type of framing has certain disadvantages in debris tunneling. Considerable unbalanced side pressures may cause the

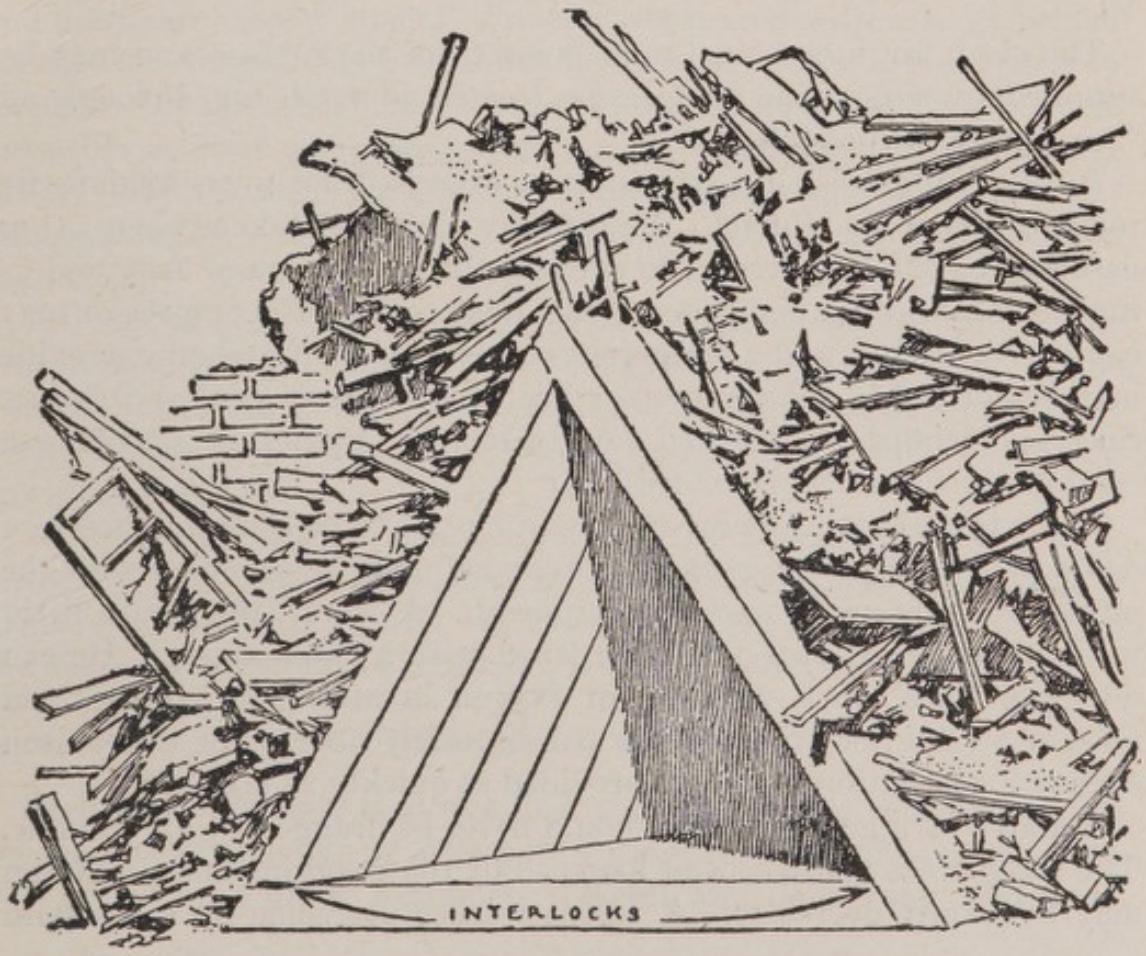


FIGURE 18.—Method of timbering a debris tunnel with a triangular form of timber lining.

frames to collapse because they are not rigid. A tunnel in debris is usually so irregular in shape that it may not be possible to hold the frames in position. The frames are held in position mainly by the weight of the debris acting on the outside. In some instances short debris tunnels of small cross section may be driven in the form of a closed triangle of heavy planks keyed together at the ends (fig. 18).

Whenever possible, a tunnel should be driven along the angle between a wall and a floor or even against a wall. This may determine the amount of timbering required, which may be props and cap pieces or even two-piece sets.

VENTILATION OF DEBRIS TUNNELS

In order for rescue workers to do their work safely and efficiently when driving tunnels or working in closed spaces, it is necessary that they be adequately supplied with pure air. Where possible, induced ventilation should be used for the purpose of controlling any contaminant (gas) that may have escaped into the atmosphere where rescue work must be done.

The quality of the air in the working place can be determined only by means of the gas-detection devices (carbon monoxide indicator, combustible-gas detector, and flame safety lamp) discussed in chapter VI.

The clean air in a tunnel must come from the surface and may be supplied by a portable compressor located in fresh air, through an "Air Mover," if possible.

In supplying fresh air, care must be exercised not to recirculate air removed from the tunnel. Precautions must be taken when using gasoline-driven compressors to prevent the exhaust gases from entering the intake of the compressor. A broken valve in a compressor may cause overheating, and a dangerous concentration of carbon monoxide may be formed in the compressor itself from burning oil and grease. Such accidents have resulted fatally to men depending solely on a compressor for a supply of fresh air.

If the tunnel atmospheres are found by test to be contaminated to a dangerous degree, Rescue Squad personnel must be provided with the proper respiratory protective equipment. A workman can do little work in tunnel driving when burdened with a "hose mask." He can do more work when wearing an oxygen breathing apparatus, and most if an All-Service gas mask can be safely used. For this reason adequate ventilation should be provided as quickly as possible.

A man wearing a respirator should never be dragged by his life line. The facepiece is apt to become loosened by the dragging and the victim may be fatally overcome. A rescue worker overcome by gas should

rather be brought out by properly equipped fellow workers. The proper use of a life line has been discussed in chapter VIII.

Men working in tunnels should be provided with electric cap lamps. They should be of a permissible type if inflammable gases are present. Furthermore, a workman provided with such illumination may be able to protect himself in event of a cave-in and even do work that may save his life in an atmosphere that would not support a flame lamp such as a carbide light. A tunnel worker cannot do much work with a flashlight as his only source of illumination.

SIZE OF TUNNEL

The size of the timbers is necessarily governed by the nature of the job and the material available. It is, however, better to make them too heavy rather than too light, in view of the uncertain weight they may have to carry.

A tunnel should be of such size and shape as to permit bringing out a casualty and should therefore not be too small nor constructed with abrupt turns. Tunnels as small as 3 feet wide and 4 feet high have proved successful. Since speed is an essential factor, and the speed at which a debris tunnel can be constructed varies with the nature of the building affected and the nature of the debris, the advantages and disadvantages of a small tunnel as compared with a large tunnel must be considered. If a tunnel is made small, there is less debris to handle. On the other hand, a tunnel must be made sufficiently large to enable at least one average-size man to work quickly, safely, and easily. If a tunnel is too small, it is difficult to remove obstructions; progress is slow, and there are many jobs at the face which one man cannot do.

The size of a debris tunnel should be considered in the light of the objective to be attained and the qualification of the workers. In the United States the average man employed in this type of work is not small, which is an important factor to be considered in planning working room.

The speed at which a debris tunnel can be constructed necessarily varies with the nature of the building and of the debris, but it may be mentioned that two tunnels, each about 25 feet long, were driven in the debris of a domestic building in 8 and 12 hours, respectively.

EFFICIENT USE OF PERSONNEL

Because of the restricted size of a tunnel, it is not usually possible for more than one man at a time to work at the face, and, as this man will be working under extremely difficult and dangerous conditions,

he should be relieved at frequent intervals. The Leader should see that only experienced men are allowed to work at any distance inside a tunnel.

When too many are employed on a tunneling operation, they tend to get into each other's way, especially in the darkness. It is a good plan, therefore, to employ only half a Squad on any one tunnel, and to give each trained man in the half Squad a turn of half-an-hour working at the face. If rapid progress is to be made and men are not to be completely exhausted, a strict rota must be worked. It is a bad practice to allow a man to work at the face until he asks to be relieved, because he is likely, in his enthusiasm, to work until he collapses and will then be useless for further work. Short periods of intensive effort by men in regular turn give best results. The rest of the men in the half Squad should be kept in continued support of the man working at the face—clearing away debris that he has removed; passing him tools, timber, etc. It may be better and quicker to have two half Squads, each tunneling for a casualty from different directions, than to have the whole Squad working in one tunnel. If one tunnel runs into very considerable obstruction and difficulty, it can be abandoned and effort concentrated on the other tunnel.

When tunneling is in progress, crowding or unauthorized talking or shouting must be avoided, as the giving and receiving of proper instructions and directions is of great importance and may be a matter of life and death.

No movement of any kind should be allowed on top of debris beneath which men are working. A strict watch should be kept for any signs of debris sliding, walls collapsing, or of any other developments that may endanger the rescue workers or further injure the people trapped.

OBSTACLES IN TUNNELING

Many obstacles of different types must be avoided or removed, when cutting through debris which may consist of heavy timbers, steel members, masses of masonry or brick work, etc. It may be necessary to break or cut these obstructions with breaking tools, or an auger, saw, or oxyacetylene torch. Before this is done, however, care must be taken to prop or firmly wedge fragments into position and timber the area so as to prevent collapse after the cut is made, as these obstructions may be key pieces supporting an enormous weight of debris.

It is difficult to tell how a beam or girder will fall or twist after it has been cut, and it is best to avoid cutting when possible. Figure 19 shows two rescue workers at the face of a recovery drift where it was necessary to cut timbers in the debris by means of an electric-

FIGURE 19.—Driving a debris tunnel in which the mass of debris consists of timbers, lumber, concrete, and steel members. Timber at face removed with augers, steel with oxyacetylene torch. Rescue workers wearing head protection and electric cap lamps for illumination.

driven auger and remove the steel members by cutting them with an oxyacetylene torch. Two bodies were recovered through this debris tunnel.

When oxyacetylene is used to remove a metal obstruction, great care must be taken to see that the debris is not set on fire. Any combustible material should be wetted and a source of water should be

readily available. Air in a tunnel is liable to become foul when oxyacetylene is being used; unless some means is employed to replenish the air, conditions may become unfit for work, and trapped people may suffer.

When heavy obstructions, such as large blocks of masonry, are encountered, it is usually quicker to work a way around the obstruction than to cut a way through.

Service gas pipes, water pipes, and conduits carrying electric cables frequently obstruct tunneling work. It is best to avoid cutting these pipes; but when this must be done, arrangements must be made before starting to seal the cut ends. If representatives of the utility services are present, they should be asked to cut off the service. Even after this has been done, there may still be gas or water in the pipes, which will escape immediately after the pipe is broken if preventive action is not taken.

As the pressure in gas pipes is low, a bung of rags or clay pushed into the open end of the pipe may suffice to stop the escape. *Both* broken ends must be stopped up in this manner. The pressure in water pipes is usually much greater, and both ends of a broken water pipe must be closed by driving in wooden bungs or otherwise effectively sealing them. Unless the pressure is turned off at the main, considerable difficulty will be experienced in trying to cut and plug water pipes of 3-inch diameter and over. The greatest possible care must, therefore, be taken and adequate preparations must be made for plugging; otherwise immediate flooding may occur.

When a building is badly damaged, the electric lighting wires are liable to be cut and become tangled; the main supply fuses are likely to have blown, and the whole circuit may be dead. It is an essential precaution, however, to find and turn off the main switch; if this is not possible all electric wires should be treated as live until it is certain that they are dead. One way of insuring that they are dead is to cut the wires with a wooden-handled (and so insulated) axe, or with a cutter (using insulating gloves). This procedure is not without danger; sparks so produced might set fire to the debris or cause escaping gas to explode.

REMOVING DEBRIS DURING TUNNELING OPERATIONS

Rubble, broken timber, etc., pulled out by the man working at the face of the tunnel must be removed by other workers and dumped clear of the work in a continuous process. The best plan is to form a human chain so that material removed by the man at the face can be quickly passed back from hand to hand until it is clear of the tunnel. For small rubble and bricks, baskets or buckets should be used and passed back and forth as required.

Where restrictions of space and other conditions make it difficult to employ the human chain method, the debris may be hauled out of the tunnel with a light rope. This, however, will require one man to crawl up to the head and attach the rope to the basket or timber at every haul.

As far as possible, the operations should be so organized that the man working at the face can quickly receive all necessary tools and timbers, and have the debris he has removed quickly cleared out of his way without having to leave his place. Although under air raid conditions this may not always be possible, it should be done wherever circumstances permit.

GENERAL PRECAUTIONS IN TUNNELING

1. Where dust is troublesome, a respirator worn over the nose and mouth will prevent serious consequences.
2. Protective helmets or hats should always be worn to prevent minor head and face injuries.
3. Dust goggles should be worn to protect the eyes from dust, etc.
4. Leather gloves should be worn as they protect against minor hand injuries.
5. Extra care must be taken, especially in the use of tools, on approaching closely to a trapped person.

SINKING SHAFTS

In some circumstances, especially where large masses of debris are involved, the best way to reach persons trapped in a basement is to sink a shaft or hole down to the basement level in the ground alongside the building, and then to tunnel from the bottom of this hole in a horizontal direction until the basement is reached, thus avoiding the danger and difficulty of cutting through debris.

The most important thing to remember is that, even though the ground may appear sound and solid, the sides of the shaft must always be supported by timbering. Rough and improvised material for this purpose can generally be obtained on the site. Figure 23 shows a typical method of timbering a hole or shaft. The timbers used should be heavy, and must be wedged into position as tightly as possible.

When a shaft or tunnel is to be driven in the earth alongside a building, the spot chosen should be one where there are no service pipes or other obstructions. Because of the probable presence of such obstacles, it is best not to sink a shaft in a roadway.

Watch must also be kept for subsoil water, as this may flood shafts or tunnels and basements if the wall is broken through.

If there is any doubt as to the success of a tunneling operation—and in debris tunnels there is usually doubt—alternative methods of reaching the victims should be tried simultaneously. If, for instance, a

large basement shelter is hit, rescue operations might be attempted simultaneously through one or more debris tunnels and a shaft in the ground outside.

BASEMENTS

Except in certain areas, most old domestic properties and nearly all large buildings have basements or cellars partly or entirely below ground level. In domestic property, the normal access to such a basement is by a small staircase situated immediately below the main staircase of the house. An important point to note about domestic basements is that most of them are provided with a window, hatch or chute immediately below one of the windows of the ground floor.

In large buildings abutting on the sidewalk, basements usually extend for a distance of 5 to 10 feet under the sidewalk and in this portion are usually found the coal and refuse chutes that afford ingress to the basement.

It is of the utmost importance that rescue workers should be familiar with the various forms of construction used in basements in their community, as unprotected basements and cellars may be used as places of refuge.

Rescue From Basements

Rescue Squads may be called upon to extricate trapped persons from the basements of demolished buildings, either when the basement ceiling has collapsed, or when it has stood up to the debris load.

The first task is to try to determine the layout and extent of the basement, the location of the entrance and emergency exit, and whether or not there are basements in the adjoining buildings. Steps should also be taken, if possible, to determine from an examination of the outside whether or not the ceiling has collapsed, and if so, in what way.

Following a rapid investigation of these matters, entrance to a basement should be effected in one or more of the following ways:

1. By breaking through the wall from an adjoining basement which has not been so severely damaged. To increase the probability of reaching quickly a lean-to which may have been formed by the collapse of the basement ceiling, it is better to break through the wall at a point near the corner of the basement. Consideration must, of course, be paid to the construction and thickness of the wall.

2. A manhole or emergency exit leading to the outside may be cleared of debris and an entrance effected in this way (fig. 20).

3. Where the ground floor has not collapsed, a small area may be cleared either by tunneling to the spot or otherwise removing the debris and cutting a hole in the floor to give access to the basement (fig. 21).

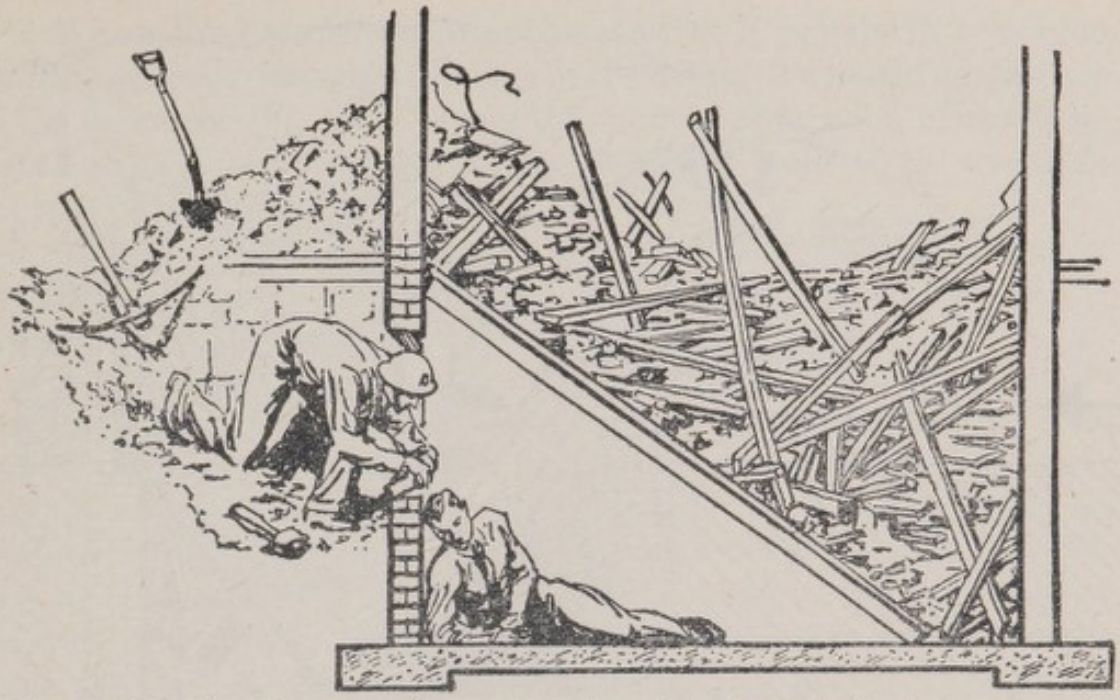


FIGURE 20.—Rescuing trapped casualty through hole made in basement wall.

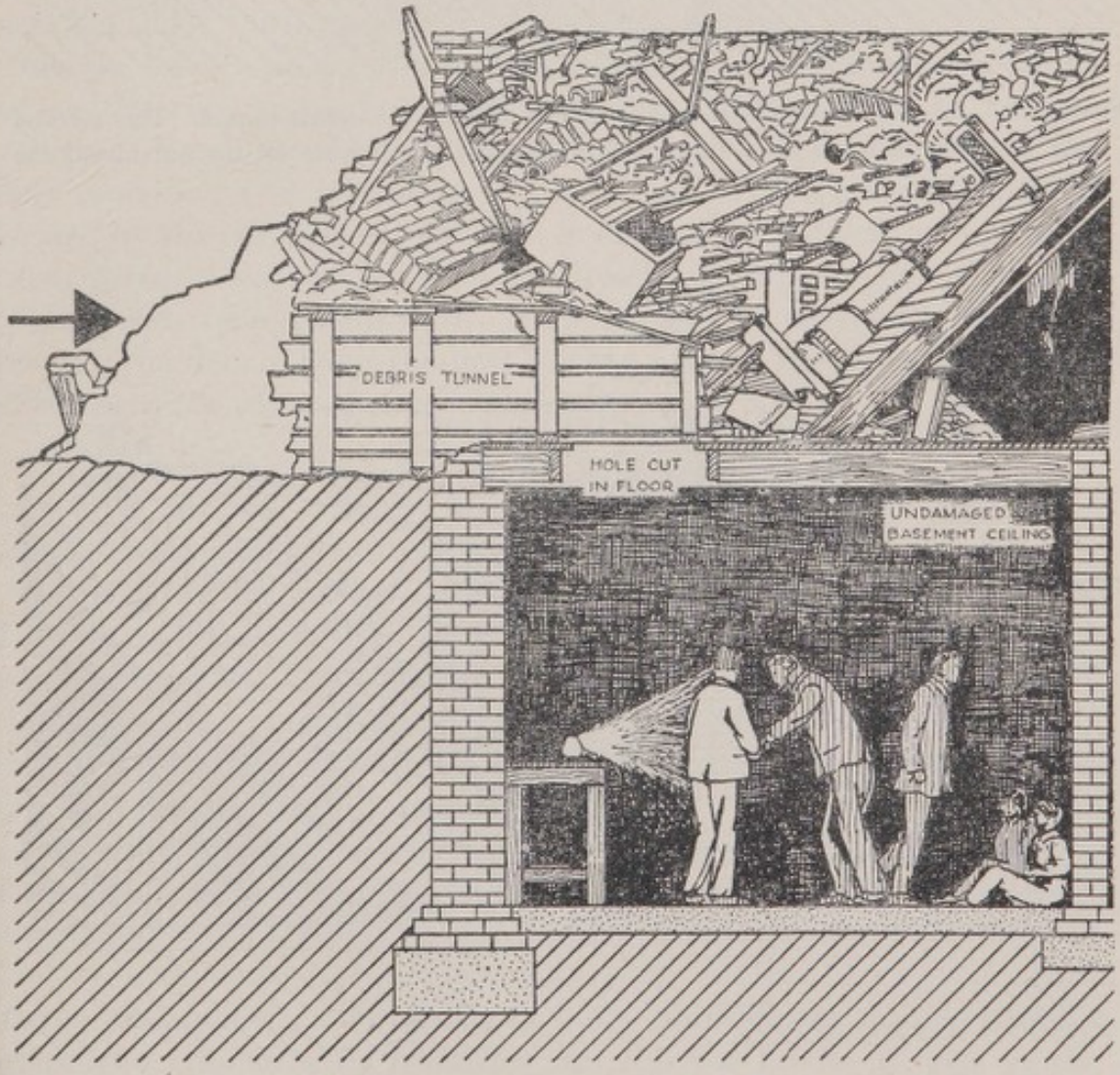


FIGURE 21.—Rescue from a basement where the ceiling remains substantially unbroken. Debris is cleared back or tunnel cut through debris until part of floor is uncovered. Through this a hole is cut providing access to basement.

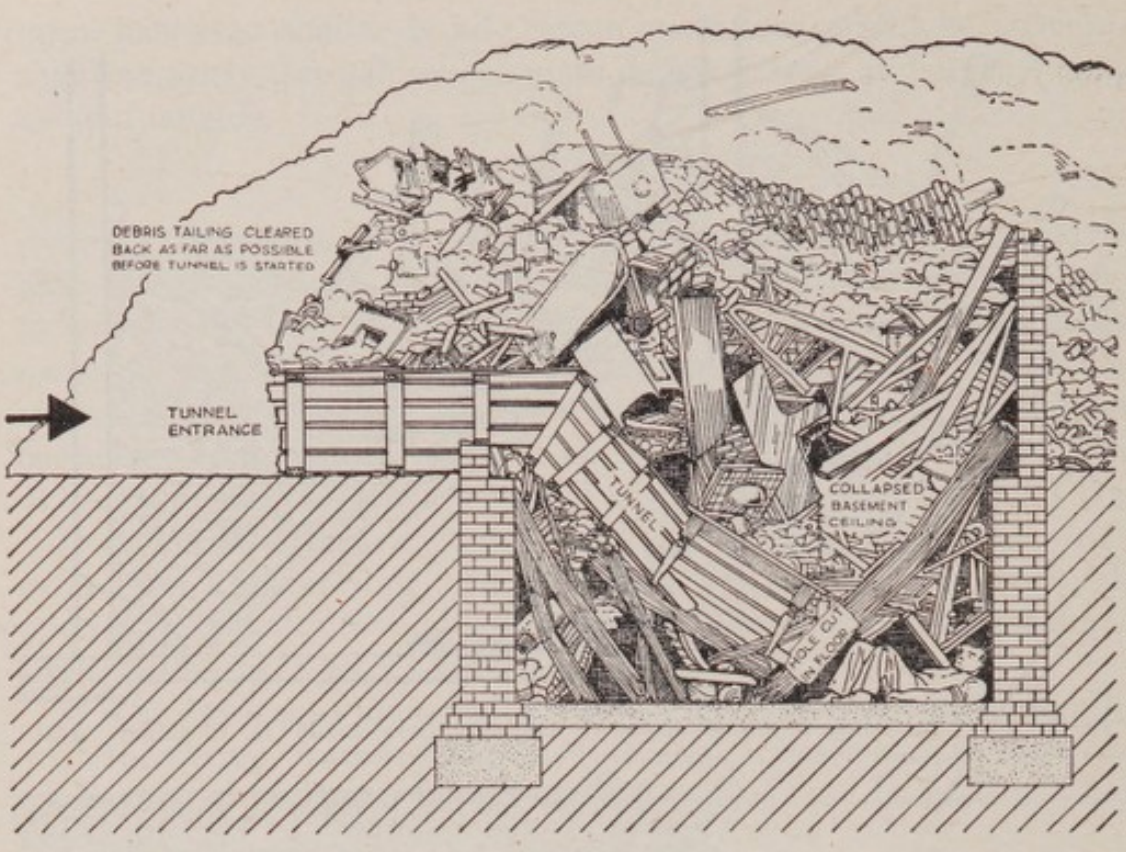


FIGURE 22.—Rescue from collapsed basement by means of a debris tunnel. This method may be possible when it is difficult or impossible to excavate on the outside of the basement wall.

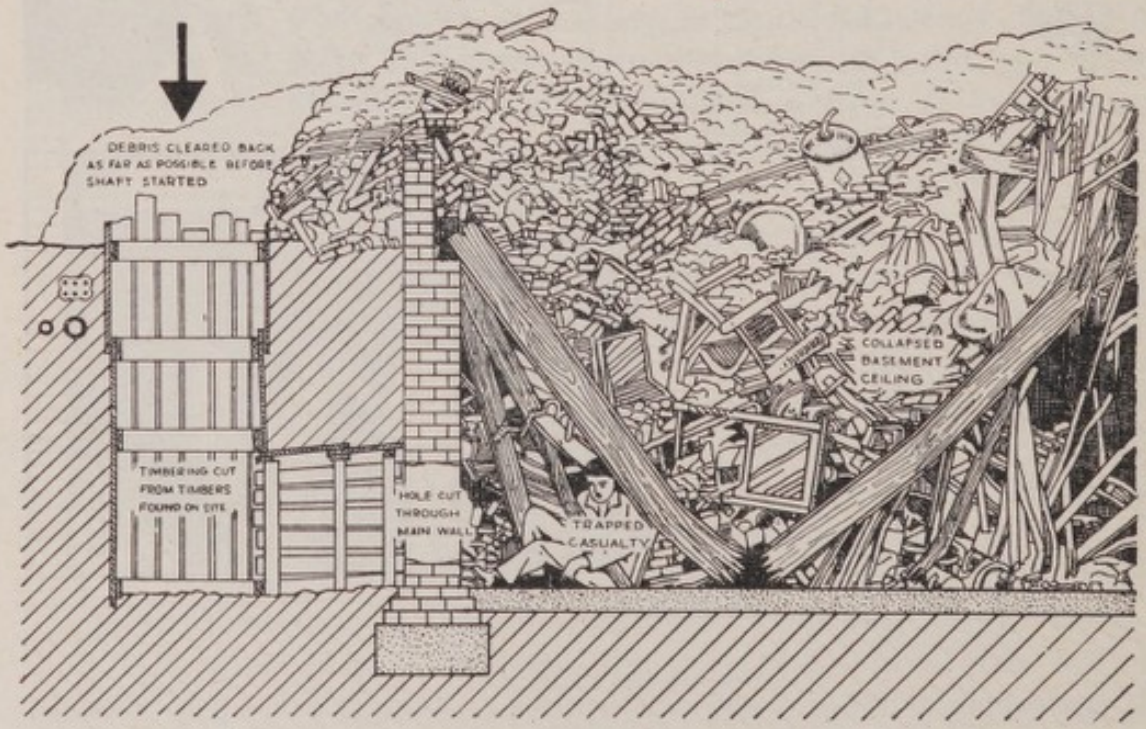


FIGURE 23.—Rescue from collapsed basement by means of a shaft sunk in the earth outside the building. This method minimizes risk of collapsing the debris before the casualty is rescued.

4. Where the basement ceiling has completely collapsed, a sloping tunnel may be driven from the edge of the debris downward to the floor of the basement (fig. 22). From this point, exploration of the basement can be continued by working round the walls to all available voids.

5. A shaft (fig. 23) or ramp may be sunk in the ground immediately outside the building, and, if possible, alongside the outer face of the basement wall, through which a hole can then be broken.

6. A tunnel may be driven through the debris to the head of a stairway leading to a basement, if the stairway can be found, and the stairs cleared sufficiently to permit an entrance to the basement to be made.

If the basement ceiling has collapsed, a solid mass of debris may be revealed inside when a hole is driven through the outer wall. In this case, a trench or tunnel should be cut in the earth on the outer face of the wall, and another hole driven through into the basement farther along the wall. Alternatively, a tunnel may be driven through the debris in the basement, following round the angle where the walls meet the floor until voids or lean-to's are reached.

Once a lean-to or void has been reached, it should at once be made safe with props and other timbers against the possibility of further collapse. Some members of the squad can do this while others are busy removing and attending to casualties. If a void or lean-to is formed by the collapse of part of a floor against one wall of the basement, there is likely—for reasons already explained—to be another void against the opposite wall. A tunnel should, therefore, be driven through the debris from the first lean-to toward the opposite wall in an endeavor to reach the second lean-to.

Breaking Through Walls

Walls may belong to one of several classes:

Brick with lime mortar.—Walls built with lime mortar, especially if they are old, are usually easy to demolish or pierce. As a rule, the bricks can be withdrawn whole without difficulty, and it is usually necessary to put in some form of headpiece to prevent the bricks immediately over the hole from falling in (fig. 24). Alternatively, the hole may be made an inverted V shape.

Brick with cement mortar.—Cement mortar is usually as strong as the brick itself. In general, holes sufficiently large for rescue purposes can be safely made in these walls. When damaged, lime-jointed brickwork tends to fall to pieces and the individual bricks lie about almost undamaged, whereas walls built with cement mortar usually break into chunks with fractures through the bricks as well as the joints.

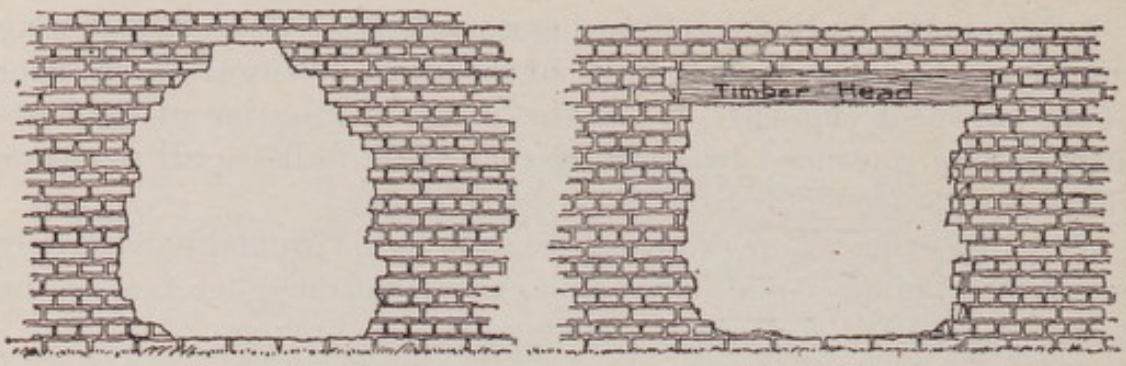


FIGURE 24.—Breaking through brickwork.

Stone.—Walls of stone may be of different types, with stones of various sizes held together by a variety of different bonding agents. Only where a hole is cut through a wall made of fairly small loose stones is any support needed at the roof. Stone basement walls are usually thick and difficult to cut.

Concrete.—It is almost impossible to cut through concrete (especially reinforced concrete) rapidly unless a pneumatic hammer is employed. Pneumatic tools should, therefore, be called for without delay whenever such work is necessary.

Except in the case of concrete, the procedure in breaking through a wall should be to cut a fairly small hole first and then enlarge it to the required size. With concrete walls it is better, unless they are very thick, to make a cut around the edge of the piece to be removed. If the walls are reinforced, the cut must be deep enough to reach the reinforcing bars so that these can be cut with hack saws or shears, or by an oxyacetylene torch.

If the oxyacetylene torch is used, care must be exercised that combustible debris is not ignited, that utility gas is not present, and that ventilation is provided. It is always advisable to have emergency fire-fighting equipment on hand when using an oxyacetylene torch. The cutting of utility gas service pipes, water pipes, and electric cables should be avoided if possible. A representative of the particular utility service involved should be consulted. (See "Oxyacetylene Cutting Apparatus," Chapter VIII.)

Unless there are other considerations, a wall should be broken through where it is thinnest, as behind a fireplace or between pillars.

When cutting into walls or floors of large buildings care must be taken to avoid weakening the main beams and columns supporting the building.

When a building has been damaged by a bomb, parts left standing and apparently sound may be severely shaken and cracked. When, therefore, walls are being cut away, especially if pneumatic tools are being used, excessive vibration should be avoided as it may lead to further collapse.

CLEARANCE OF SITES

One of the greatest problems in rescue operations is caused by the frequent inability to obtain quickly reliable and complete information on missing persons. After the four stages concerned with recovering casualties have been completed and all persons known to have been trapped have been rescued, or their bodies recovered, persons still missing and believed to be at the site can be recovered only by the systematic clearance of the whole site (Stage 5). At this stage of the work, the senior officers of the local Rescue Service must determine when the incident has ceased to be a rescue job and has become a matter of general debris clearance to be undertaken by demolition and clearance crews of the local public works department or private companies.

It is essential that an incident should not be called "closed" until the fullest search and investigation have been completed. An important aspect of site clearance is the satisfaction given to relatives, friends, and the general public that everything possible has been done to recover missing persons.

The job of clearing the site is probably the hardest physical task confronting the Rescue Squads. The clearing of sites is best performed in daylight; it may be possible to do the work at the same time that trenching and tunneling are still being carried on if it is thought that clearance will expedite recovery of the victims. In the clearance of sites the fullest use should be made of heavy construction equipment, but it should be employed only when the debris is clear of human remains and rescue and recovery operations have been completed.

While the rescue work is in progress, careful check-up should be made at hospitals as well as at morgues to ascertain whether persons reported missing have been received at these institutions. There usually are unidentified bodies at morgues after heavy air raids, and proper identification may reveal persons reported as missing from the damaged area. Parts of bodies, clothing, and personal effects recovered from the debris may also give valuable information concerning missing persons. Experience has shown that human beings, as well as debris, may be scattered over a wide area by bomb explosions and may fall into unexpected places.

CHAPTER XV

Shoring and Demolition

Shoring and demolition work may be undertaken while Stages 2 and 3 are in progress (Immediate Rescue and Exploration) if rescue work can proceed without interruption.

Shoring and demolition work undertaken by Rescue Squads should normally be limited to that required to enable Civilian Defense personnel to carry out their duties with safety, and to prevent further injury to casualties. Rescue Squads should not spend too much time in elaborate shoring; they should erect only such temporary shoring as is necessary to meet urgent requirements.

SHORING

Shoring is a method of temporarily bracing or supporting the walls of a building by means of posts or struts (shores). Shoring is used to brace up a wall that threatens to fall, or to prevent a wall from falling when an adjoining wall is removed. It is also used to support a wall while the lower portions of the wall are being altered or removed.

Shores are made of timbers of various sizes. In the choice of suitable timbers of the proper sizes for shoring, especially if improvised or salvaged timber has to be used, it is better to err on the large side. For shores that are from 15 to 20 feet in length the cross-section through the timber should be at least 6 inches by 6 inches. When the shores are from 40 to 50 feet in length, the timbers should be at least 12 inches by 12 inches.

Methods of Shoring

Shores may be used to steady a wall or to hold it in position while excavation is going on next to it. This is particularly necessary when the wall is *out of plumb*, or not vertical, or when it bulges out. The shores in such cases should be placed as nearly horizontal as possible against the wall. Shores such as these are sometimes called *bracing*, *pushing*, or *raking shores*.

Shores are also used to support part of the weight of the wall when alterations are being made at the lower part as in "B", figure 25. The shores in such cases should be placed as nearly vertical as possible as at *b*. Such shores are called *lifting shores*.

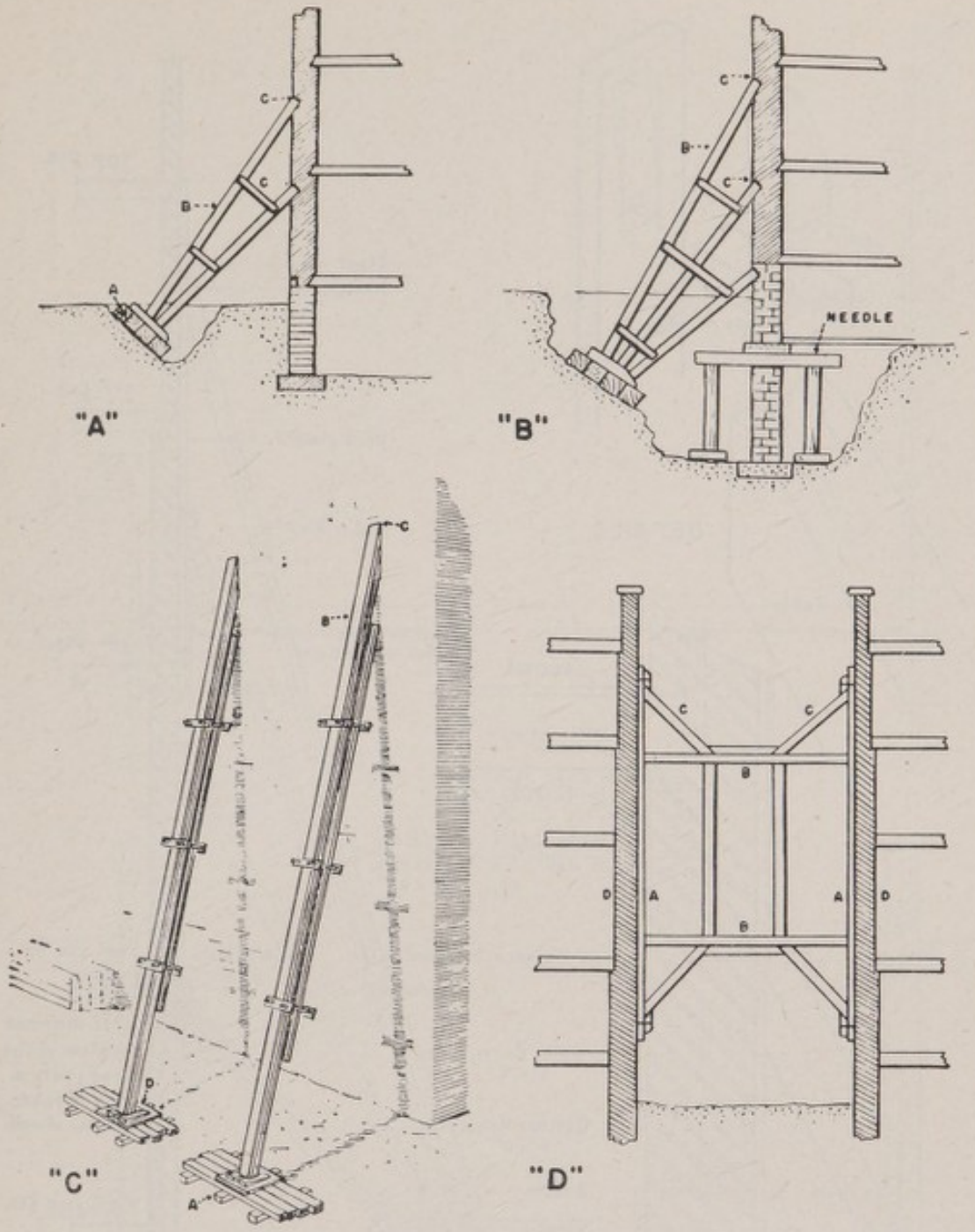


FIGURE 25.—Various types of shores.

The upper ends of the shores should be placed as nearly opposite the floor beams as is possible so that there will be no danger of the walls' being pushed in between the floor levels. The holes *c* are cut in the wall so that the brickwork or other wall material will bear firmly upon the shores. In most instances it is desirable to place a wall plate between the wall and the shore timber.

Sometimes single shores are used as in "C", figure 25. In this instance two timbers are used, one of which acts as a reinforcing member and is placed on the under side of the shore and held in place by clamps, as shown. The entire upper end *c* of the shore enters the wall and receives a bearing.

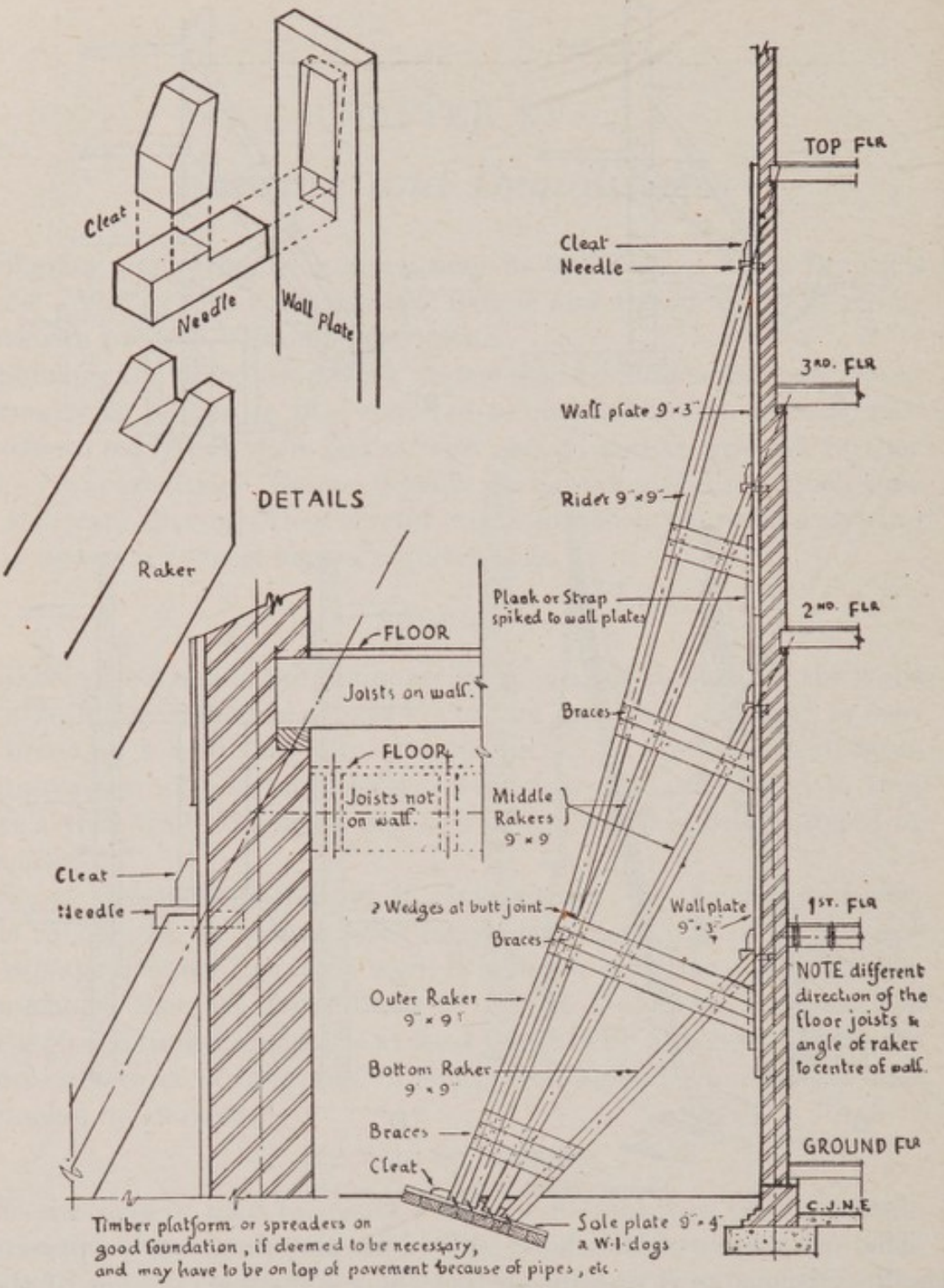


FIGURE 26.—Raking shore.

Shores that are used in supporting weight are sometimes driven up by means of wedges such as those shown in "C", figure 25 at *d*, and sometimes by screw jacks, or jacks. Wooden wedges should be made of very hard wood, since they must be capable of lifting the loads with a great deal of force. Hammering such wedges jars the walls and may produce disastrous effects.

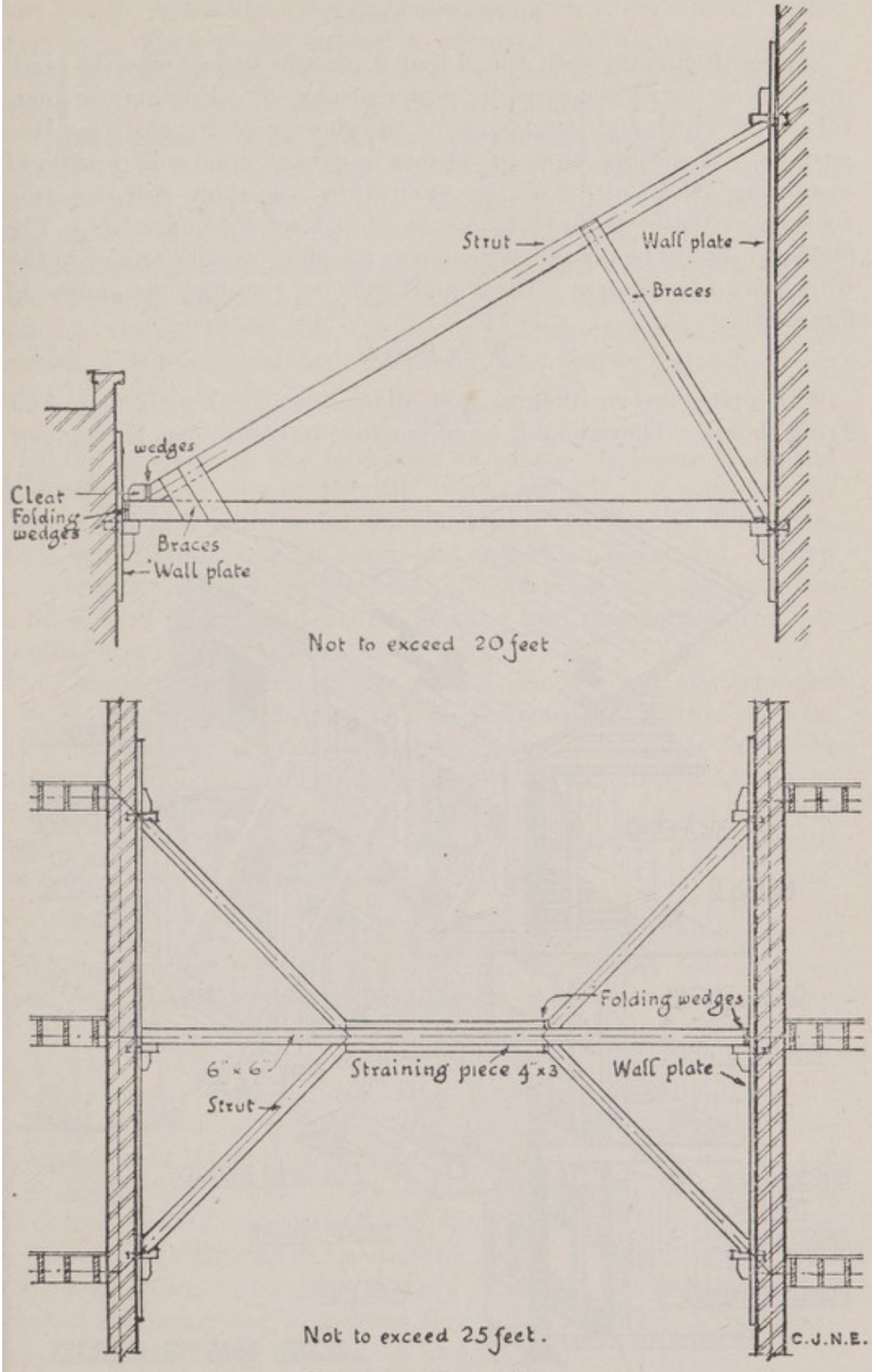


FIGURE 27.—Flying shores.

Footing of Shores

Shores often carry such a load that it must be spread over the earth in accordance with the resisting power of the soil. Footings, or platforms, on which the lower ends of the shore rest are built for this purpose. If a shore supports 30 tons and rests upon soil capable of sustaining a load of 3 tons per square foot, the shore will require a footing, or platform, having an area of at least 10 square feet. The platform should be placed, as nearly as possible, at right angles to the direction of the shores. These platforms, or footings, are shown in figure 25.

Wall Plates

Wall plates are an integral part of bracing or raking, lifting and flying shores. They should, when possible, be continuous throughout

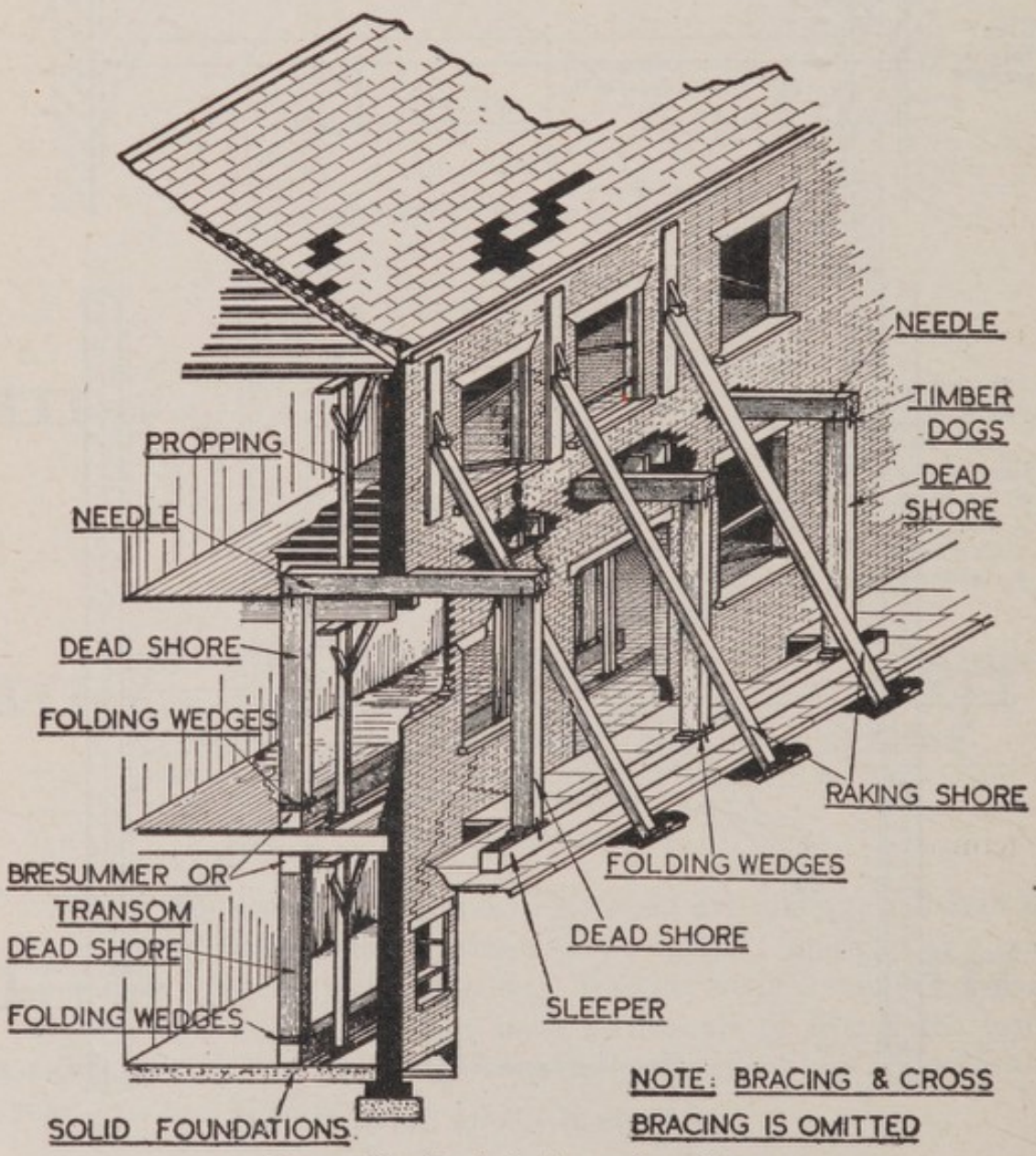


Figure 28.—Dead shoring and needling.

their length, especially when in connection with brick masonry construction. When placed against a distorted or bulging wall, they should be backed with timber pieces so that a continuous bearing against the wall is provided. Timber with a cross-section of about 9 by 3 inches makes suitable wall plates for average purposes.

At the point where a shoring member meets the wall plate, a needle made of wood or other suitable material is inserted through the wall plate into a hole of proper size in the wall. The needle is strengthened against the thrust of the shore timber by having a cleat fixed above it. Cleats can be mortised into the wall plates or simply spiked to them. If possible, the head of the shore timber should be notched to fit the underside of the needle, as shown in figure 26.

Jacks

By the use of jacks, the force used in lifting the shores is applied gradually without jarring the wall. When a single jack is used under a shore, the jack must be left in place until the shoring is finished. When more lifting power is required, two jacks may be used. When the shore has been forced into place, the space between the jacks can be filled with timbers and wedges and the load transferred from the jacks, after which they can be removed.

The screw of a jack, known as a *pump screw*, is sometimes arranged to work into the end of a shore which is hollowed out for that purpose.

Hydraulic jacks are sometimes used when great loads are to be supported or lifted, but the loads should not be allowed to rest on them for more than a short time, as they are apt to leak and allow the shore to drop. Blocks and wedges should therefore be put under the shore as soon as possible after it is raised.

Bracing

When adjoining buildings have been built originally with common walls, or walls supporting the floor beams of two buildings, and one of these buildings is to be torn down or has collapsed, the adjacent walls should be guarded against falling by *spreading braces* or *inclined shores*, also called *flying shores*. When there are buildings or walls on each side of the collapsed or open area, the walls of these structures may be supported by spreading braces. (See figs. 25 and 27.) Struts may be fixed at an angle of 45 degrees to the horizontal beam so as to give support to the top and bottom of both wall plates. The struts are tightened in position by means of straining pieces and wedges as shown in fig. 27. When a flying shore has to be placed between walls carrying more than three floors, a double flying shore should be used. (See "D", fig. 25 and fig. 27.)

When the distance between the walls to be supported is not more than 25 feet, the braces or shoring may be arranged as shown in "D"

figure 25. At *a*, *a* are 6- by 12-inch uprights against the walls, *d*, *d*, to distribute the bearing of the braces; at *b*, *b* are the spreaders, and at *c*, *c* the angle braces, all of which may be 8- by 8-inch timbers.

If the walls are from 40 to 50 feet apart, the spreading braces should be trussed, which calls for work of expert carpenters. Although spreading braces or inclined shores should be built by a carpenter, it is essential for the rescue worker to know how they are constructed in order that he may be of assistance.

Needling

Needling is the process of supporting the upper portion of a wall upon horizontal beams or girders called *needles* while the lower part of the wall is being altered or tunneled. The ends of the needles are supported by means of vertical posts (dead shores), jack screws, or timbers piled up horizontally which convey the load from the needles to the ground. The vertical uprights should rest on a sleeper or sole piece which should be as long and as wide as can be conveniently used, so as to spread the load as much as possible. Care must be taken not to place a sleeper on a cellar arch or floor without making sure that the arch or floor will carry the added load.

Other types of shoring are often used simultaneously with needling as shown in "B," figure 25 and in figure 28, to support part of the weight of a wall and to prevent its sidewise movement while it is resting on the needles. As soon as two needles are in place, a section of the wall directly under or between the needles is removed and the space between them made large enough to admit a rescuer; or the material directly under the two needles can be removed only enough to permit a collar or timber-head for roof support to be placed between and under the two needles. The collar is then a beam supported at its ends by the material directly beneath it and the needles. The material in the center can then be removed.

Precautions in Shoring

Shoring is one of the most difficult branches of construction work and cannot be guided by definite rules. A practical shoring engineer should supervise and inspect shoring projects. It is desirable that the services of a practical shoring engineer be utilized in training members of Rescue Squads. A carpenter who is skilled in shoring should be a member of every Rescue Squad.

Although there are many occasions when ladders must be used in erecting shores, their general use should be discouraged. If a passageway is to be used for any length of time in rescue work for any purpose, including the building of shores, safety and speed will be obtained by the building and use of substantially built temporary stairways with railings, wide enough for at least two men to pass.

Scaffolds may be necessary in erecting shores. A scaffold, though temporary in use, is as important with respect to good design and safe construction as is the structure which it serves. The selection of the proper type of scaffold should be made by one whose experience, training, and knowledge can plan and direct the erection of a safe scaffold. A scaffold should be erected and taken down by experienced men, and should not be used unless their safety is assured by careful and frequent inspections. Discarded material lying around an incident is not good enough for temporary staging in all instances. Scaffolds used on walls should be self-supporting, especially on a burned or bomb-wrecked building.

DEMOLITION

Demolition is associated with many dangers. Experience and skill are required, even when the wall or structure to be demolished is quite small. Rescue-work demolition must take into account the people trapped in or under the debris.

Buildings or parts of buildings can be demolished in three different ways:

1. By removing the wall or building piece by piece, working from the top with picks, hammers, crowbars, etc.
2. By toppling over large portions by means of a cable and tractor, truck, or winch.
3. By using explosives under expert supervision.

The method employed at any particular incident will depend upon the working space available, the degree of urgency of the demolition, and the stability of the building. Although the first method is the safest and should be employed when time permits, it is such a slow process that it is rarely used in rescue operations where speed is essential.

It is obviously not desirable to use explosives for demolition work in rescue operations involving the extrication of victims, as further damage may be done to already unstable buildings and the work of extrication made still more difficult. In any event, explosives should be used for demolition work only by men of considerable experience, and Rescue Squad personnel should not ordinarily be instructed in the use of explosives.

Planning the Work

Before the actual work of demolition is begun, a careful study should be made of the wall or structure to be demolished and of its surroundings, particularly the latter, in order that the removal of the critical structure will not introduce a more dangerous factor. A definite plan of procedure should then be mapped out and followed. This is especially important where speed is essential, as in rescue work. In formulating the plan it is necessary to consider the security

of adjoining buildings, the pile of debris, and above all the predicament of trapped casualties, in order to make adequate provision for their safety.

All utility services, such as gas, electricity, and water, should be shut off and any windows or glass doors not already broken should be removed before demolition is begun.

Shoring Adjoining Structures

Shoring of adjacent buildings is often imperative, and full provision should be made for carrying out all necessary operations of this kind promptly, thoroughly, and safely.

If a structure has been wrecked in whole or in part by fire, explosion, or the collapse of an adjacent building, such as occurs during an air raid, it may be necessary to shore or brace some of the walls of the adjoining building in order that any part can be taken down with relative safety.

Order of Procedure

Demolition should always proceed systematically, story by story, and the work on the upper floors, if any, should be completed before any of the lower sections are disturbed, unless the wall is to be toppled over as a whole.

Demolition of Walls by Toppling (by Cable)

This is the second method of demolition used by Rescue Squads. The cable should be attached and pulled in such manner as to obtain the greatest possible mechanical advantage against the weakest part of the wall. Three problems are involved:

1. Selecting or creating a line of weakness in such a position on the building or wall that the whole of the brickwork above this line can be toppled over in one operation, and, when toppled over, will fall in some safe and convenient direction.

2. Attaching the hauling cable in such a manner as to get as good a hold and as great a mechanical advantage as possible.

3. Hauling on the cable in such a manner as to achieve the desired result without risk to the personnel or victims.

To regulate the fall, it is necessary to estimate where the breaking line is likely to be, and, if there is no obvious line of weakness, to create one by cutting away sufficient material at a suitable point, so that as much of the wall as desired can be demolished in one operation and the greatest possible leverage obtained with the hauling cable. Any such cutting of material should be undertaken after the hauling cable has been attached, and, where indicated, from the face of the wall away from the direction of hauling.

The cable must be arranged so as to get as good a hold on the wall as possible and distribute the pull over the largest possible area above the line of weakness. This can be insured by placing heavy timber battens against the back of the wall along the line where the cable is applied. This will prevent the cable from cutting into or through the wall, and is especially necessary with old walls built in lime mortar or with very soft masonry.

When a cable has to be attached to a severely damaged and unstable wall, it may not be safe to use a ladder in the ordinary way. Usually, the cable can be placed in position by the use of light hauling lines, or, if necessary, by a standing derrick. Alternatively, a ladder rigged with guys may be used as a derrick to enable a man to climb up without bringing any weight on the wall, but great care must be exercised in using ladders in this way, as it subjects them to a much greater strain than usual.

The method of hauling will depend on the circumstances and on the equipment available. It can be done either by means of a winch or by some power-driven vehicle, such as a tractor or truck. In hauling, three important points arise:

1. The longer the hauling cable, the more nearly horizontal it will be and, consequently, the greater the effective pull.
2. To obtain the maximum overturning effect, the line of pull should be as nearly at right angles to the face of the wall as possible.
3. The hauling cable must be long enough to insure that the wall will not fall on the tractor or other hauling machinery.

Damage to the hauling equipment will be avoided if the cable is slackened as much as possible the moment the wall is seen to be falling. When a winch is used, the drum should be allowed to run free as soon as the wall begins to collapse, so as to relieve the cable and drum from any shock.

Miscellaneous Precautions

Where a derrick is used, care should be taken to see that the floor or base on which it is placed is amply strong for the load to be imposed. Overloading of equipment should be avoided.

One of the principal dangers in demolition work is from falling objects. To protect men who may be working below the actual demolition operations, all possible openings should be kept covered.

If oxyacetylene cutting equipment is to be used for cutting steel members of walls or buildings which are being demolished, it should be undertaken only by an experienced man who understands the process, and the precautions in the use of such equipment, given in Chapter VIII, should be followed.

CHAPTER XVI

Use of Ladders, Ropes, and Lashings

LADDERS

There are several types of ladders, but the work of the Rescue Squad can usually be accomplished by the use of a straight ladder (8 to 10 feet long) and an extension or two-piece ladder 35 feet long (when extended).

Ladders should be checked regularly to make sure they are sound. In the checking of extension ladders it is necessary to make sure that locks, pulleys, and ropes are in working order, and that the ropes are in good condition and have not become chafed. Pulleys and rung locks should be lubricated frequently. Chances should never be taken with a defective or damaged ladder.

There are eight terms used in connection with ladder work, which are:

1. Beam: The long member of the ladder, there being one on each side through which the rungs are fastened.
2. Round or Rung: The cross members used for footing, which run between the beams.
3. Heel, Foot, or Butt: The bottom end of a ladder.
4. Tip: The top of a ladder.
5. Main or Bed Ladder: The lowest section of an extension ladder.
6. Fly Ladder or Fly: The upper or top section of an extension ladder.
7. Halyard or Fly Rope: The rope used to haul up the fly or top section of an extension ladder.
8. Tormentors or Tormentor Poles: Independent poles used to push up, guide, and steady long extension ladders, and to brace the ladders when placed in position.

Methods of Carrying

The methods of carrying ladders depend primarily on whether a short single ladder or a long heavy ladder is used. In the four-man carry, the ladder is carried horizontally by two men on each end who carry the end between them with the beams on their adjacent shoulders. The beam is held by the inside hand of each man. In the case of a two-man carry, each man may carry the ladder with the upper beam resting on his right shoulder between the second and third rungs and

grasping a rung or lower beam with his right hand, or the upper beam may be placed under the right arm at the armpit and the lower beam held with the right hand.

Placing a Ladder

The base of a ladder should not be placed too close to a building or wall, as a nearly vertical ladder is hard to climb and is liable to tip backward away from the building. If the foot of a ladder is placed too far from a building, the load which the ladder can carry is decreased below capacity and the foot or butt is apt to slide out away from the building. The foot of the ladder should be placed at a distance, measured horizontally from the wall, equal to one-fifth of the ladder's extended length, plus two feet. For example, if an extension ladder is being used and the part of the ladder actually in use (i. e., its extended length) is 35 feet, the foot of the ladder should be placed 9 feet from the wall or building.

Raising a Ladder

When a ladder is being raised, precautions should be taken by making sure that the ladder will not come in contact with charged electrical wiring or conduits or other electrically energized metal piping. A ladder should be so placed that wires will not come in contact with it, or fall on it in case they should melt or break.

The method of raising a straight ladder is shown in figure 29. The man at the right anchors the foot of the ladder by bracing with his toes on the beams, his heels on the ground, and his hands on the second rung from the foot to help pull the ladder up and at the same time to make sure that it will not slip. The man at the left takes the ladder at one of the rungs about one-third of the ladder's length from the top, moves down the ladder toward the foot, and "walks" with his hands from one rung to another, pushing the ladder up, until it is vertical. Both men lift the ladder slightly and turn it toward the wall or building, or it may be tilted slightly and swung on one beam as an axis. One man then stands on the side of the ladder away from the wall and anchors the foot of the ladder with his feet and pulls against the rung about shoulder high with his hands while the other man draws the ladder toward the wall and pushes against its weight in order to bring it into place gently. If a window is to be entered, the top of the ladder should be about 18 inches above the sill (fig. 30) and on the far left side, so that a man working on the ladder gets off of it on the right.

Once a ladder is in position, it should be made fast to the window sill or ledge, fire escape, or some other convenient object by means of a ladder dog, lashing line, or wire bond (fig. 30). Each Squad

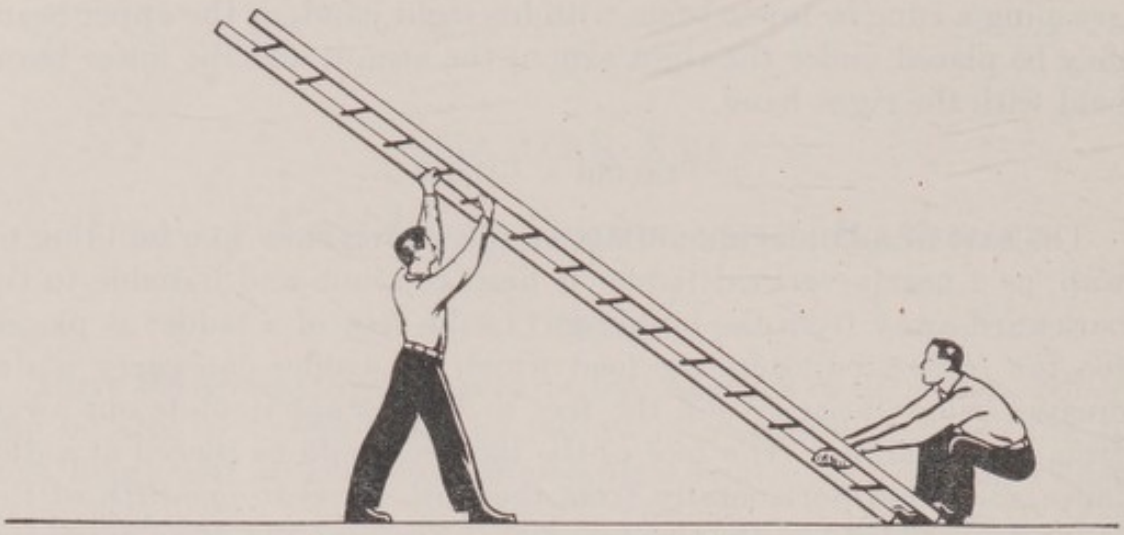


FIGURE 29.—Raising a straight ladder.

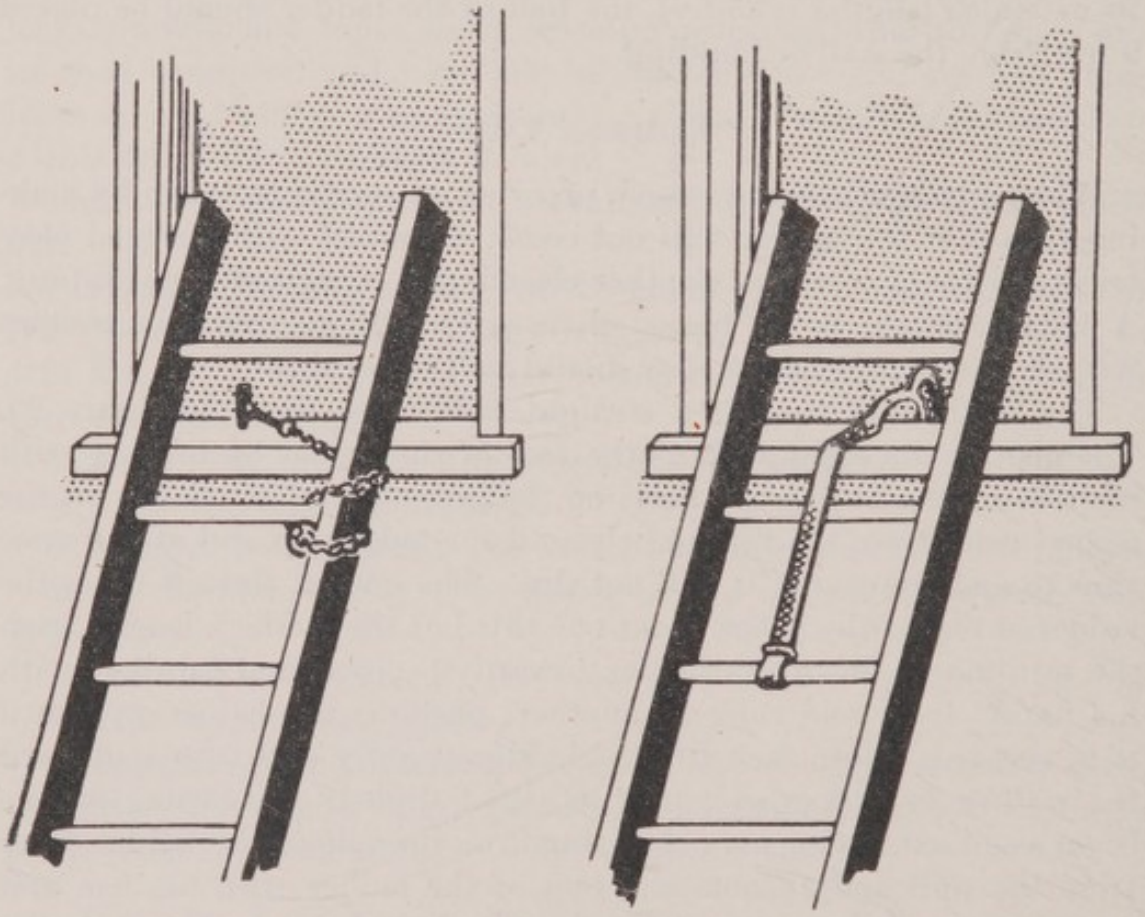


FIGURE 30.—Ladders locked in position by means of dogs with the tips placed about 18 inches above sill on far left side.

member should be able to fasten and unfasten the attachment used for securing the top of the ladder.

A small extension ladder, such as would be used by a Rescue Squad, should be raised in the same way as a straight ladder with the fly unextended. The fly side of the ladder should be placed on the side of the main or bed ladder (that is, the bottom ladder) which is away from

the wall; i. e., the bottom ladder should be nearer the wall than the fly ladder. When the ladder has been raised to a vertical position, one man should hold the beams about shoulder high (fig. 31), while the other pulls in on the fly rope until the ladder has been raised to its required height.

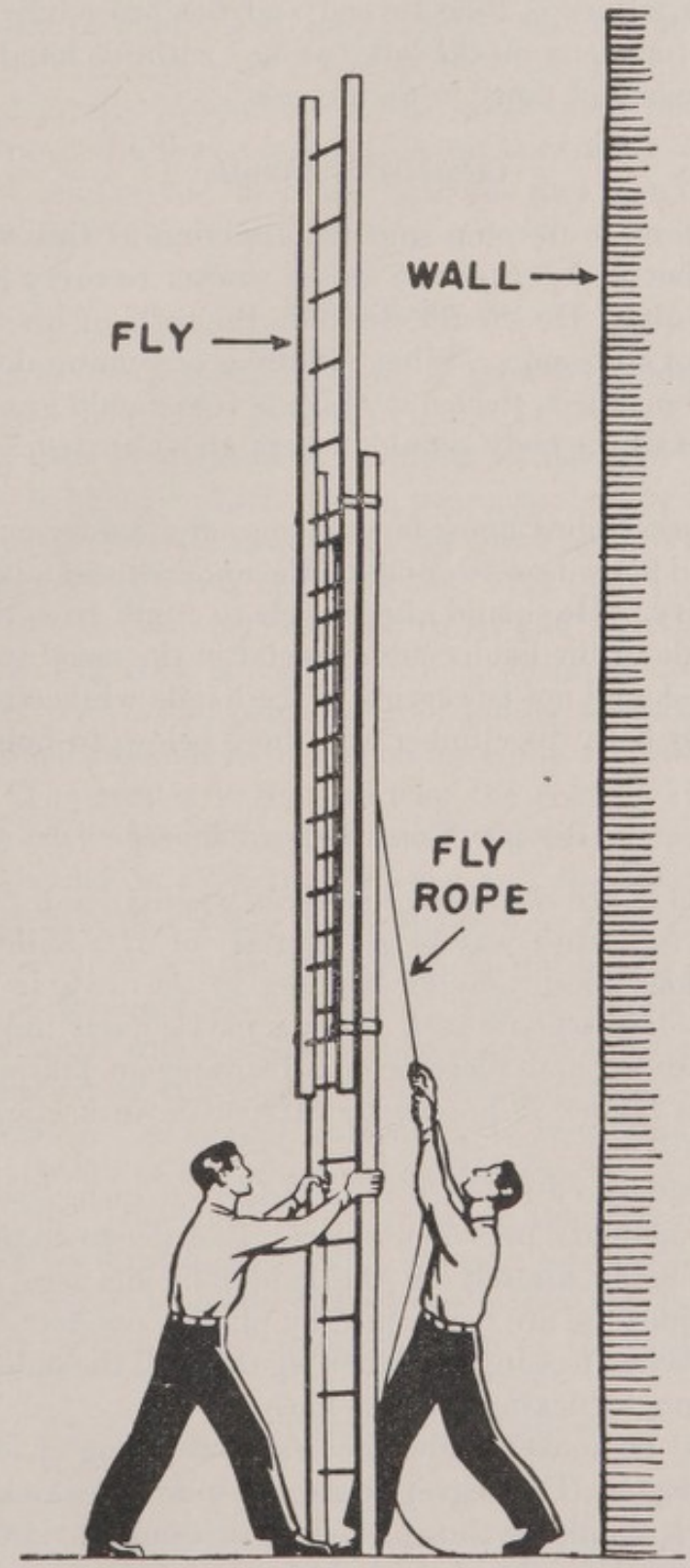


FIGURE 31.—Raising an extension ladder.

Lowering a Ladder

To lower a ladder, in general, the process of raising a ladder is reversed. The ladder is first pulled away from the wall or building, one man having secured the foot of the ladder from sliding. If an extension ladder is to be taken down, the fly or upper section is first lowered. The ladder is then turned and the procedure is reversed; i. e., the man (or men) on the left "walks" with his hands toward the top, letting the ladder down in the process.

Climbing a Ladder

It is important to develop smooth climbing, as this will not only insure safety but will permit the rescue worker to carry heavier loads with less difficulty. He should climb on the balls of his feet and step on the center of the rungs. When climbing or coming down with one hand carrying an object, the hand which is free should grasp the rungs. The upper part of the body should be kept about an arm's length from the ladder.

A rescue worker must know how to step off a ladder onto a window sill. He should know how to climb on the underside of a ladder, should this be necessary. He should also be able to climb from the underside to the outer side of the ladder and descend in the usual way.

Equipment should not be carried in the hands while climbing. It is much safer, for both the climber and those below, to hoist and lower tools by rope.

Rescue Work Using Ladders

Although there are numerous instances when a ladder may be used to advantage, the safest way to get in and out of a building, if there are no hazardous conditions or barriers in the way, is through the natural means of entry and exit. This is particularly important when rescuing casualties, and there is no advantage in taking an injured person down a ladder if he can be carried down a stairway or fire escape.

It is often necessary to work on a ladder in such a way that both hands are free to hold a person or object. In order to do this the rescue worker must steady himself on the ladder by his legs alone. Leg-holds for this purpose are performed by placing one foot firmly on the rung near one beam, passing the other leg through the ladder and holding it to the rung by flexing it at the knee.

The foot may be hooked under the next lower rung or locked around the adjacent beam. The leg opposite the side on which the rescuer intends to work should be thus locked. For example, if the rescuer is going to work to the right of the ladder, the left leg should be locked.

If the ladder is correctly placed, the bottom generally need not be held but nevertheless *should always be attended* when in use for rescue work.

Pick-a-Pack

This maneuver is useful when the ladder is a little too short to reach a high window or roof. Two men then mount the ladder one behind the other, the first man with a coil of rope for use in hoisting equipment needed later. Near the top, the upper man places his feet on the shoulders of the lower man who then continues to ascend slowly with the first man on his shoulders until the first man can easily reach the sill or roof and climb up.

Roof Work

If work must be done on a roof, it should be done from a roof ladder. After the regular extension ladder is in place, the roof ladder is raised by two men like any straight ladder and laid along one beam on the ladder up which it is to be carried. The top man climbs up and when his shoulder is opposite the third rung of the roof ladder, he gets a leghold and sets the hook out. He then picks up the roof ladder on his shoulder between the third and fourth rungs.

The ladder can then be carried into position as follows: The top man when in position to place the roof ladder locks with his left leg and passes the ladder ahead of him on his right, the lower man feeding it to him. The ladder is then slid up the roof on the sides of one beam or the back side of the hooks until the hooks are over the ridge pole. The ladder is then turned over and the hooks are engaged securely. To take the ladder down, the process is reversed.

A ladder, such as a roof ladder, can be hoisted by a rope. To do this, the rope should first be fastened with a half hitch on the left beam of the ladder where it is joined by the next rung above the middle rung. A section of the rope a short distance from one end is used for this purpose. A second half hitch is then made on the right beam of the ladder at the other end of the same rung, using the other end of the rope. The ends of the rope are then brought together at the middle of the next highest rung, where a bowline loop is tied with the short end. The long end of the rope is then continued up the ladder from the bowline loop along the side of the ladder next to the building.

Rescue Through a Window

The ladder should be placed at the window through which the person is to be rescued. If the person is severely injured, unconscious, or

extremely heavy, a stretcher should be used and lowered as described in the manual on *Field Care and Transportation of the Injured.* If the injured person can be handled easily and is not seriously injured, it is preferable to carry him down the ladder. The fireman's lift should be used for this purpose.

ROPES AND TACKLE

The erection of derricks, the shoring, bracing or stabilizing of disturbed portions of buildings, demolition work, and the handling of material by rescue workers require the use of ropes and tackle. Rescue Squad personnel should therefore be familiar with the handling of ropes and tackle and be able to tie various knots and make certain fastenings with speed and proficiency. Knowledge of proper procedures in handling ropes and tackle can be learned only by demonstration, practice, and experience.

Tackle is the part of lifting equipment which is most apt to fail. Tackle failure may result in the dropping of a load, entailing the risk of injury both to members of the Rescue Squad and to casualties. Dropping a load on a pile of debris may critically disturb the rubble over a trapped victim.

So that it will always be immediately available for safe use, tackle must be kept in efficient condition. Blocks must be kept clean, free from grit and dirt, and well oiled; all pins, straps, and hooks must be secure and in good working condition; pulleys must operate freely and not squeak. Tackle should *always be carried* from one place to another and *not dragged* along the ground. It should always be clean and dry before it is put away.

Reef or Square Knot

The reef or square knot will not slip and can be untied readily. It is a double knot in which the free ends of the second tie lie in the same plane as the end of the first tie. In making a reef or square knot, a single granny knot is first tied, then the ends are turned until they lie parallel to the rope. One end is turned back across the knot on the same side of the rope, and the other end is crossed over the first end to complete the knot, as shown in figure 32A.

Granny or Thumb Knot

The ordinary granny or thumb knot (fig. 32B) should be tied in a rope only when its purpose is to stop a rope passing through a block or to prevent fraying at the cut end of a rope until the end can be protected by whipping.

Half Hitch

This knot is formed by passing the short end of a rope around the timber (fig. 32C) or around another rope under the standing end, so that when pulled, one part of the rope binds on the other. A half hitch on the timber itself as in figure 32C would not be secure, whereas the half hitch formed on the standing end of the rope as in figure 32E will hold while the timber is being raised.

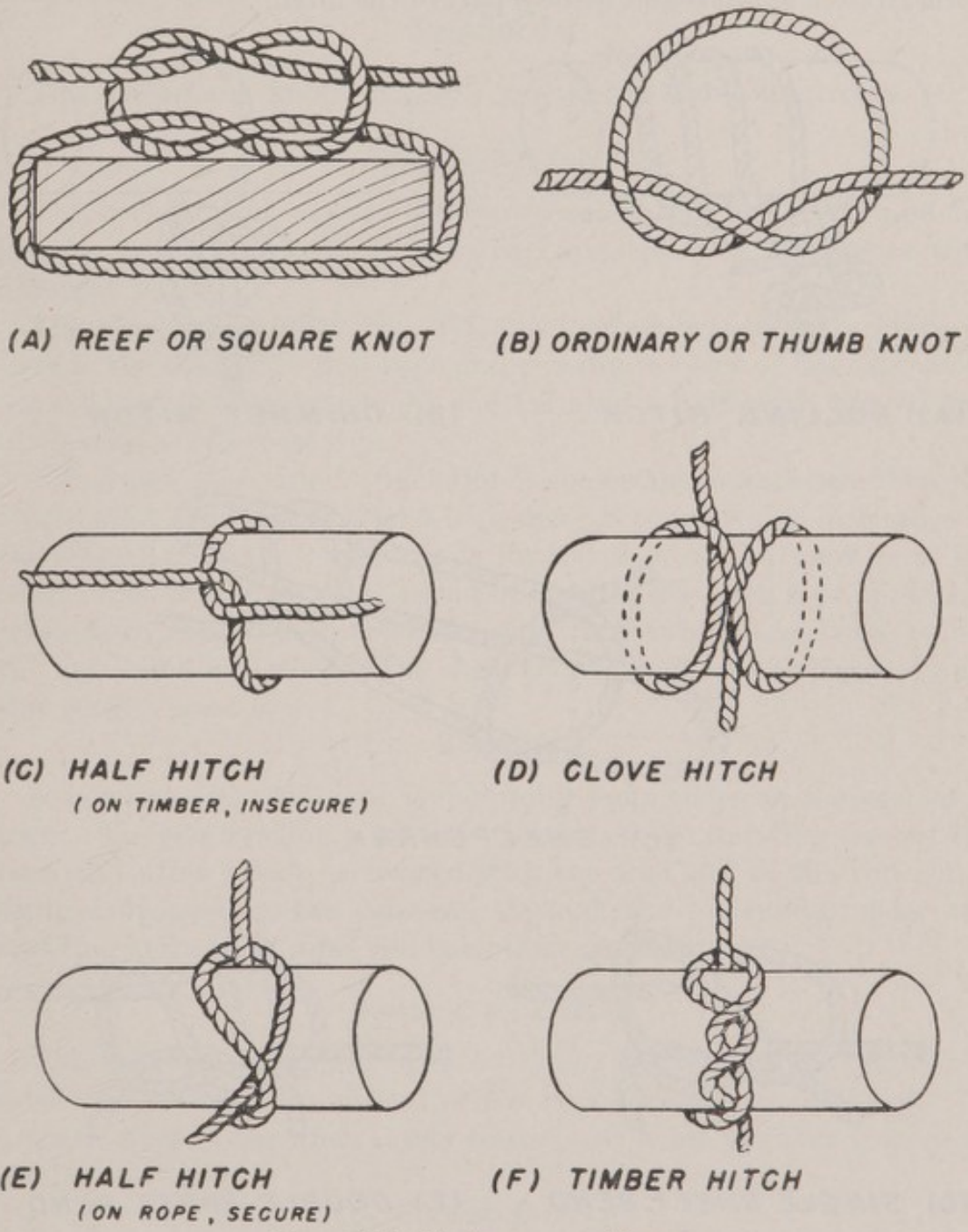


Figure 32.—Various types of knots.

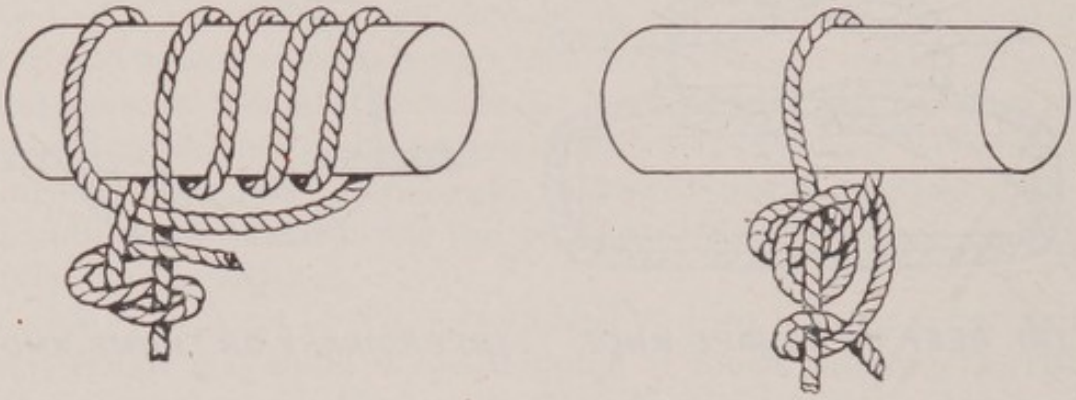
Clove Hitch

A clove hitch (fig. 32D) is used for making a rope fast to a timber or pipe or a small rope fast to a larger one. It is formed by two half

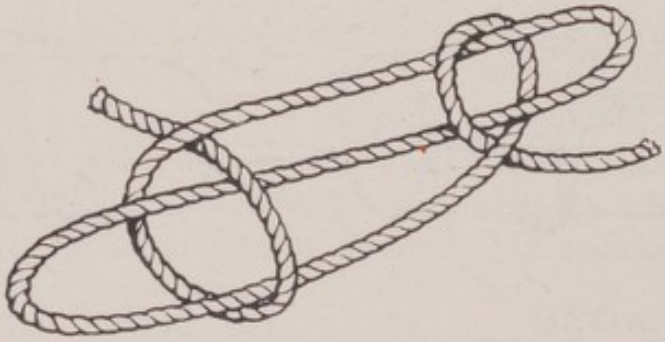
hitches, one reversed. The ropes in passing over one another bind and form a secure hitch that will not slip readily.

Timber Hitch

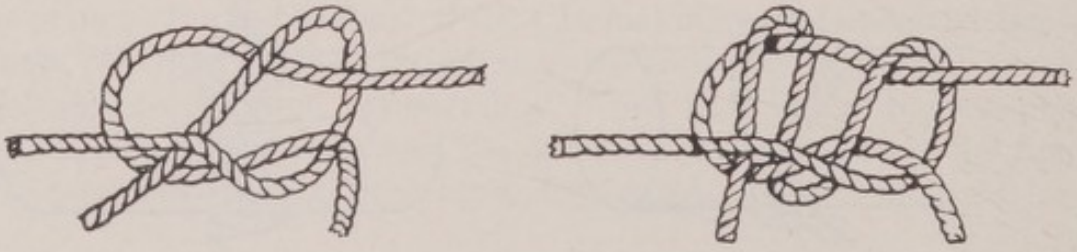
A timber hitch (fig. 32F) is a quickly made knot used to secure a rope to a plank or other timber, and is formed by making a half hitch on the standing end of the rope, leaving a long end which is twisted back again round its own part of the hitch.



(A) ROLLING HITCH (B) CHIMNEY HITCH



(C) SHEEPSHANK



(D) SINGLE SHEET BEND (E) DOUBLE SHEET BEND

Figure 33.—Various types of knots.

Rolling Hitch

A rolling hitch (fig. 33A) is a strong hitch that will not slip. It is used to attach a rope to a timber, pipe or other rope when consid-

erable resistance to slipping is needed. This knot is formed in the same way as a clove hitch, but with an intermediate round turn between the two half hitches.

Chimney Hitch

A chimney hitch (fig. 33B) is an easily made knot that will not slip and is an excellent knot for holding heavy loads when the rope is to be anchored.

Sheepshank

The sheepshank knot (fig. 33C) is used for shortening ropes.

Becket (or Sheet) Bend

The becket bend, also called the "sheet" bend, is a knot used for joining ropes, especially of different diameters, or two ropes with different pulls.

The single sheet bend (fig. 33D) is formed by making a bight or loop in the thicker or first rope and passing the end of the thinner or second rope through the bight and forming a half hitch around two thicknesses of the first rope.

The double sheet bend (fig. 33E) is somewhat more secure than the single sheet bend and is used where there is considerable difference in the diameters of the ropes. It is formed in a similar manner to the single knot except that the second or smaller diameter rope is given a round turn around both thicknesses of the first or thicker rope before the half hitch is formed. The sheet bends (double and single) do not slip when a rope is wet.

Bowline

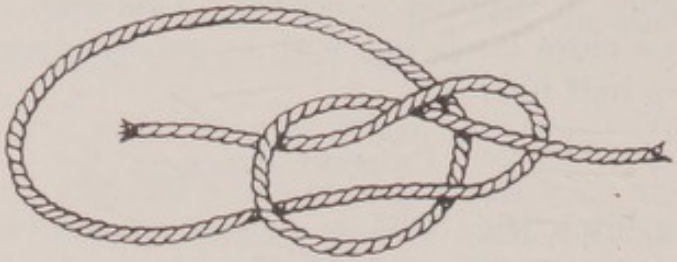
A bowline (fig. 34) is a nonslipping loop made on the end of a rope. To tie a bowline, a hitch is thrown on the standing part of the rope and after a loop is formed with the free end of the rope, it is secured by passing the free end through the underside, under the standing end of the rope, and back through the hitch.

Bowline on a Bight

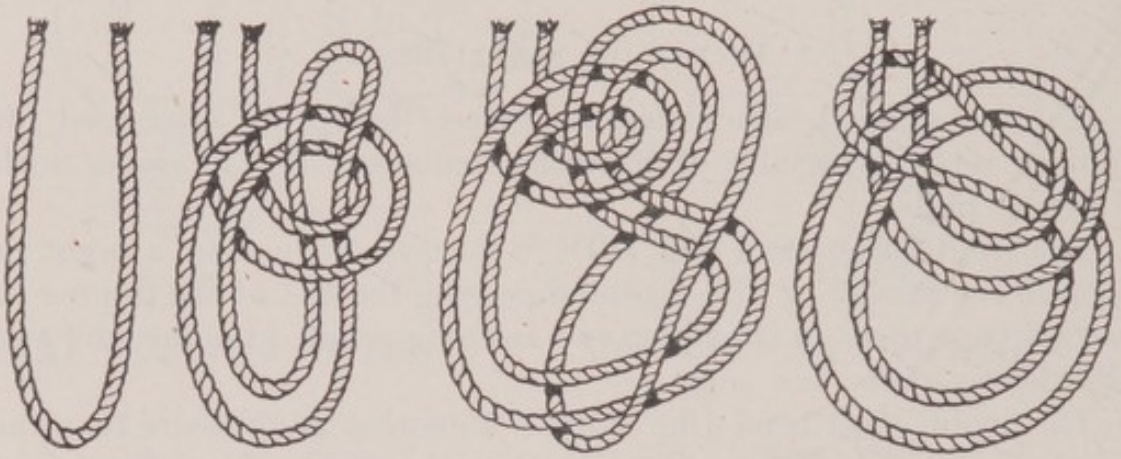
The "bowline on a bight" (fig. 34B) is a double loop that should be used when lowering an injured person on a stretcher from a height. It is a safe knot to use when safety to the load is the primary consideration.

Coiling Ropes

A rope should always be coiled properly. To coil a rope properly it is only necessary to reverse the procedure of uncoiling a rope which is supplied coiled in the first instance. Coiling it backward will unlay the rope. In coiling with the hand, the end of the rope should be



(A) BOWLINE



(B) STAGES IN TIEING BOWLINE ON A BIGHT

FIGURE 34.—Bowline on a bight.

picked up in such a way that the coil is formed in a clockwise direction. If a rope is properly coiled it can be uncoiled easily without kinking.

REEVING TACKLE

To rope up or "reeve" a tackle, two men should stand back to back, about 6 feet apart, with the blocks slightly in front of them between their feet and the hooks pointing outward. The coil of rope to be reeved should be to the right of the top or lifting block which is to be roped or reeved up by the first man. The next step is for each man to place his left foot on his block to hold it firm. The first man should reeve the "standing end" of the rope through the lowest sheave (i. e., the one lying on the ground) of the top block, then pass it to the second man who will reeve it through the lowest sheave of the second block. The rope should be passed successively through the sheaves of both blocks from right to left and the "standing end" finally made fast to the ring or becket of the second block. The running end of the rope should be knotted to prevent it from slipping. The "running end" of the rope is the loose end, and the "standing end" is the fixed end.

Twisting of Tackle

The force required to lift a load is almost doubled if the rope reeved in the tackle has one complete twist. There is also the danger that when a heavy load is carried by twisted tackle it may break loose and swing around, and cause injury or structural damage.

It is, therefore, important that the rope be prevented from twisting. The twisting of tackle is due to the lay of the rope, and there is no special method of reeving that will entirely prevent it, particularly with a new rope, although thorough stretching of the rope before reeving will help.

Tackle may be prevented from twisting when it is being used for hauling purposes by placing a crowbar or pick handle through the knot at the fixed end of the rope and at right angles to and between the "returns" or moving rope sections. The pick handle can be controlled with a lightweight rope used as a guy line and secured to one end of the pick handle by a rolling hitch knot.

LASHINGS

Lashings are used mainly to secure two or more poles firmly together.

Square Lashing

The square lashing is generally used to hold two poles together at right angles to each other. The stages are:

1. Start with a clove hitch (fig. 35a) around the standard, below the ledger, and wrap the long and short ends together as at *b*. Take the twisted ends up and around both standard and ledger in direction of arrow *above* the clove hitch.

2. Repeat this circuit three or four times, drawing the rope as taut as possible (fig. 35, Stage 2).

3. Take four frapping turns *c* around the whole lashing between the spars, draw very taut and finish with a close hitch *d* on the ledger.

Diagonal Lashing

The diagonal lashing is used to hold together two poles at an angle, especially to prevent them from springing apart. There are three stages:

1. Start with a timber hitch (fig. 36a); then take four vertical turns *b* and draw all taut.

2. Take four horizontal turns *c* and draw taut.

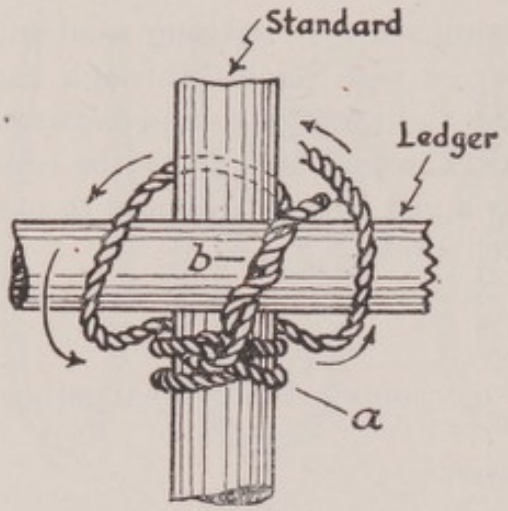
3. Finally, put four frapping turns *d* over the lashing, between the spars, draw taut, and finish with a clove hitch *e*.

Care of Manila Ropes

To ensure the efficiency of manila ropes, *always:*

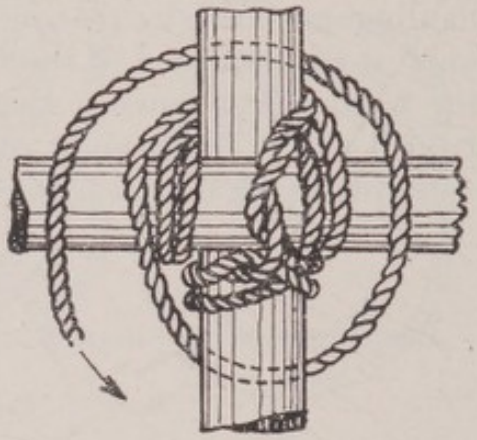
1. Stretch a new rope throughout its length before using it. To do this attach one end to a swivel hook (to allow twisting) and pull on the rope.

2. Avoid cutting a rope unless it is essential to do so. If it is necessary, ensure that the cut end is whipped as soon as possible to prevent fraying. As a temporary measure to prevent fraying, tie a thumb knot near the end of the rope.

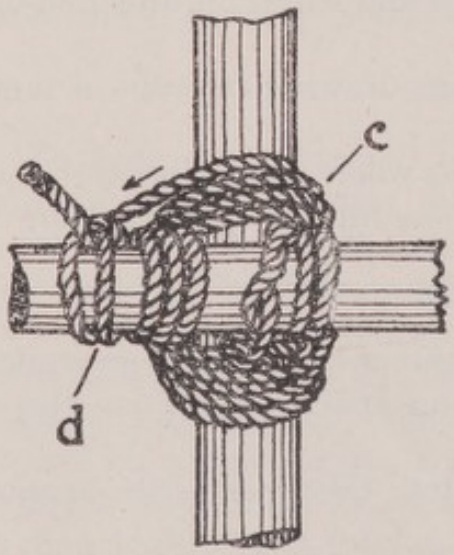


Stage 1.—Start with a clove hitch (*a*) round the standard, below the ledger, and wrap the long and short ends together as at (*b*).

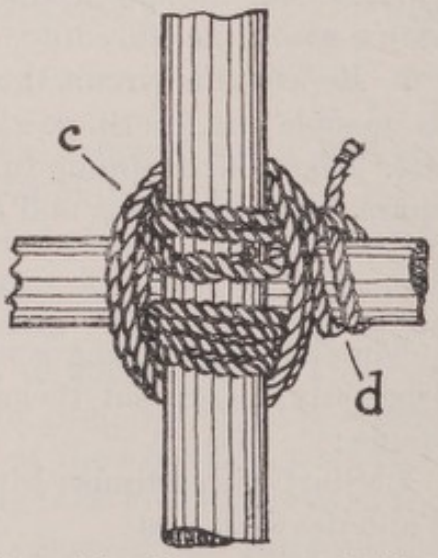
Take twisted ends up, and around both standard and ledger in direction of arrow *above* the clove hitch.



Stage 2.—Repeat this circuit three or four times, drawing the rope as taut as possible.

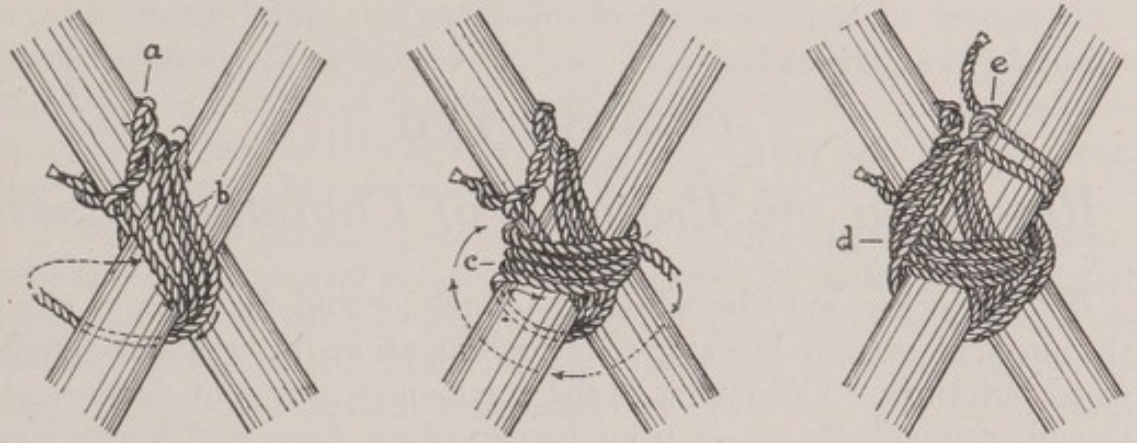


Stage 3(A).—Take four frapping turns (*c*) around the whole lashing between the spars, draw very taut and finish with a clove hitch (*d*) on the ledger.



Stage 3(B).—The square lashing complete as viewed from the back.

Figure 35.—Square lashing.



Stage 1.—Start with a timber hitch (*a*) then take four vertical turns (*b*), and draw all taut.

Stage 2.—Take four horizontal turns (*c*) and draw taut.

Stage 3.—Finally, put four frapping turns (*d*) over the lashing, between the spars, draw well taut, and finish with a clove hitch (*e*).

FIGURE 36.—Diagonal lashing.

3. Avoid knots in a rope, as they considerably reduce its strength.

4. Do not attempt to force a thick rope through a tackle block made for a smaller rope; e. g., a 4-inch rope through a 3-inch block. This produces a strain on the rope and lessens its strength.

5. Avoid passing a rope over a sharp edge. If it is necessary to do this, protect the edge with a sandbag or a piece of rounded timber.

6. Avoid sudden jerks or violent stress on the rope, as this weakens both the rope and any tackle used with it.

7. As far as possible, keep a rope dry. If it gets wet, do not attempt to dry it in front of a fire. Loop it loosely over a ladder or rail so that it can get plenty of air. This is particularly necessary with manila rope, which contains its own oil and becomes brittle and unsafe if dried by heat.

8. Store fibre ropes under cover off the floor, preferably on racks in a place free from extremes of temperature and out of contact with materials containing any acid, strong alkali, or creosote.

9. Examine ropes every month for external damage and rotting of fibres.

10. If rope in coils has to be left in a place where it may be exposed to the weather, cover it with tarpaulin or some other form of protection.

11. Whenever a rope has been used, be sure that it is clean and dry before it is coiled and stored.

CARE OF WIRE ROPES

Wire ropes should be cleaned with a rag after use and well oiled before being stowed away. Care must be taken that the coils are not so small that the strands are damaged.

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CHAPTER XVII

Rescue in the Presence of Common Gases

Rescue workers must be constantly on the lookout for common gases that may be present in dangerous concentrations in or about demolished buildings. Utility gas is the commonest source of danger, although refrigerants, gases from furnace flues, fires, and sewers and gas from bomb explosions in confined places also constitute definite hazards. To rescue workers and trapped casualties, these gases offer the hazards of (1) explosion, (2) toxic effects, including asphyxiation and death, and (3) displacement of air so that the oxygen content of the atmosphere is reduced to or below the danger level.

UTILITY GAS

The presence of utility gas should be anticipated and guarded against in the debris of any building which has had gas service. As a matter of fact, old, unused, and disconnected service pipes buried

FIGURE 37.—Damage caused by an explosion of about 600 cubic feet of utility gas-air mixture, leaking in from old buried abandoned gas service pipe.

outside the building, and gas mains in the street may be fractured by bomb explosions, and the gas may seep into the basement and permeate the debris. Serious explosions have occurred from such gas leaks in buildings which had no gas service. The utility gas hazard must, therefore, always be considered until it is ruled out.

There are two types of utility gas, which differ in important characteristics: (1) natural gas, which is composed of methane and related hydrocarbons which are nontoxic but form explosive mixtures with air, and (2) so-called "artificial gas" (coal gas or carburated water gas), which contains large quantities of carbon monoxide in addition to hydrogen and some hydrocarbons, and is both highly toxic and explosive in a wide range of concentrations. Natural gas is the common utility gas in the central States and throughout the South and Southwest; artificial gas is commonly used in the East and the Pacific Northwest.

These gases are lighter than air and, therefore, tend to rise and to seep upward through debris. Toxic and explosive concentrations may occur at high levels in the debris, even when no gas service was present in the original building, through accumulation and trapping of such seepage in closed voids, parts of rooms, etc.

Detection of Utility Gas

The nose may detect the presence of gas, but the absence of a recognizable odor is not a dependable indication that dangerous concentrations of utility gas are not present. Not only is carbon monoxide, the most dangerous component of utility gas, odorless, but other odors may mask the characteristic odor of the utility gas. Gas-detection equipment, described in Chapter VI, should be used whenever available. There are several types of gas detectors: the flame safety lamp and the electrical and chemical-reactive detectors.

The flame safety lamp (fig. 9) will determine the presence of concentrations of natural gas, and will be extinguished if the oxygen content of the air is dangerously reduced. It must not, however, be used in the presence of artificial gas or other gases which contain carbon monoxide, hydrogen, or petroleum vapors. It may cause explosions in mixtures of these gases with air. The flame safety lamp must be properly assembled and used in a careful manner or it becomes a hazard in itself.

Electrical detectors (combustible-gas detector, fig. 10), for the detection of the presence of explosive gas, and chemical-reactive detectors (carbon monoxide indicator, fig. 11), for the detection of poisonous gases, are valuable in that they will indicate and warn of a very low concentration of the gas. Extremely low concentrations of carbon

monoxide may be tolerated for a time and permit rescue workers to work in shifts not extended beyond the safe limits of exposure. These limits can be determined *only* by quantitative measurements. Such measurements are also necessary to insure the continued safety of a confined space which has been cleared of gas by induced ventilation and into which gas may again be seeping.

Biological methods of determining dangerous concentrations of gas are of some value in experienced hands. Canaries and mice are used to a limited extent to determine dangerous concentrations of carbon monoxide. They must not be depended upon by persons untrained in their use.

Guarding Against Explosion

To produce an explosion, both an explosive mixture of gas and air and a means of ignition must be present. Any mixture of gas and air must be considered explosive until it has been definitely determined to be safe in this respect by quantitative measurements with gas detectors. It must be remembered that an accumulation of gas above the explosive level will be rendered explosive by the admission of sufficient air to bring the concentration of the gas down within its explosive range. Explosive mixtures must be diluted and dissipated as rapidly as possible by induced ventilation.

A spark or open flame may set off an explosive mixture. Such a spark may result from a steel object, such as a tool or even a boot nail, striking a rock, from static electricity generated by friction, or from an electric arc, occurring when a switch is opened or closed or an electric circuit is otherwise altered. Flashlights, cap lights and other illuminating devices may also cause disastrous sparks; these devices should be of a permissible type, approved by the U. S. Bureau of Mines as being constructed with proper safeguards against such accidents.

The greatest care must, therefore, be exercised in an explosive atmosphere to avoid causing sparks by any method. Electric switches, cables, and other apparatus should not be disturbed until the atmosphere is rendered safe from explosion.

SEWER GAS

Sewers may contain dangerous quantities of mixed gases, but most of them arise from the leakage of utility gas into the sewer system. Hydrogen sulfide may occur in sludge and be released in dangerous concentrations under certain conditions. In extremely low concentrations it is detectable by its rotten-egg odor, but in concentrations as low as 0.06 percent it is rapidly fatal even before exposure is recognized. It also creates an explosive mixture in certain concentrations.

REFRIGERANTS

In addition to ammonia and sulfur dioxide, which are readily identifiable by odor, a number of organic compounds are in present-day use as refrigerants. Most of these are relatively nontoxic under ordinary circumstances, but may be decomposed in the presence of heat to form highly poisonous and irritating products. Extreme care should be exercised, therefore, in carrying on rescue operations in the presence of refrigerant gas escaping from air conditioning equipment, particularly if fire has been present. If possible, work should be carried on upwind of the escaping gas and induced ventilation utilized.

PETROLEUM VAPORS

These are both toxic and explosive. High concentrations rapidly saturate and render ineffective any type of mask canister, so that hose masks are necessary if induced ventilation cannot be employed to dissipate the vapor.

OTHER INDUSTRIAL GASES

Many types of gases, including acidic and organic poisons and irritants, may be released around certain types of industrial plants. Chemists associated with such industries should be consulted both in training rescue workers who may be required to serve at such plants and in actually carrying out rescue operations in the plants in the event of an incident.

PERSONAL PROTECTION

The various types of personal protective equipment are described in Chapter V. The correct equipment must be selected on the basis of the job to be done and the hazards present. The most efficient and satisfactory method of providing safe working conditions is to remove the dangerous gases by ventilation of working spaces. Whenever this is done, rescue workers can operate with increased efficiency because they are unimpeded by the wearing of a respiratory protector, which is the only alternative. Ventilation is likewise the only method of rendering the atmosphere around the trapped casualty safe until it is possible to reach and provide him with a proper respiratory device.

The selection of respiratory protective equipment, to be used under given conditions, should be based upon:

1. The conditions that create the actual or potential exposure.
2. The hazardous properties of the atmosphere in which protection is required.

FIGURE 38.—Hose mask equipped with blower and life line. Wearer about to explore opening under pile of debris.

3. The nature of the duties to be performed by the person who wears the equipment and the encumbrance or restrictions to movement permitted in the working environment. This is especially important when a choice must be made between "hose masks" and other types that provide greater freedom (fig. 38).

4. An understanding of the principles of protection, the general design, scope of use, advantages, disadvantages, and limitations of available kinds of equipment for respiratory protection.

5. The intelligence, training, physical fitness, and experience of the persons who will use the equipment.

6. The facilities for maintenance, upkeep, and supervision of use.

7. Approval of the type of respiratory equipment by the U. S. Bureau of Mines.

The limitations of the various types of canister masks, which do not supply life-maintaining oxygen, must be kept in mind. A hose mask supplies fresh air, but its usefulness is limited by the length of hose which can be employed. The hose itself impedes the movements of the worker. Oxygen breathing apparatus permits the worker to operate independently of an outside air supply, but the apparatus is heavy and complicated, and considerable training and practice are required before it can be used safely under field conditions. One or

the other of these methods of supplying air to the worker must be employed, however, when concentrations of toxic gases or vapors exceed the limits for the safe use of canisters or when the oxygen concentration in the atmosphere is decreased below the danger point.

No rescue worker should enter a space suspected of containing gas without proper respiratory protection and without properly equipped fellow workers standing by in case the rescuer should be overcome. A life line should be maintained to the innermost working space, by which a helpless worker may signal and may possibly be pulled out of a dangerous atmosphere. Many workers not equipped with proper respiratory protectors have sacrificed their lives by rushing into a dangerous atmosphere to rescue an associate who has collapsed. The personnel of the local gas company may be of great assistance in controlling gas at incidents and in furnishing gas-detecting devices and personal protective equipment to rescue workers, and instructing them in their proper use.

CHAPTER XVIII

Rescue in the Presence of War Gas

When war gas is reported at an incident, a Rescue Squad must exercise great care in approaching the gassed or contaminated area, and in carrying out rescue operations at the scene of damage.

The Leader may be informed by the Control Center before the Squad leaves that blister (vesicant) gas is present at the incident, in which event the Squad will dress in protective clothing (without hoods) and will leave their personal clothing, cash and valuables at the Rescue Depot.

If blister (vesicant) gas is not reported, protective clothing for each member of the Squad will be carefully stowed on the truck in such a way as to prevent damage by folding, crushing or rubbing against heavy articles or jagged edges during transport. In closed trucks, facilities for hanging up the clothing may be provided at the front of the vehicle, and tools, etc., loaded behind. In open trucks, part of the front end should be partitioned off to form a trough, in which the clothing should be laid loosely and preferably covered.

Protective clothing should not be folded or packed for transport until the Squad is ordered to an incident. If unused, the clothing should be unpacked and rehung in the Depot as soon as the Squad returns to it.

DRESSING IN PROTECTIVE CLOTHING EN ROUTE

Blister (vesicant) gas may be encountered or reported by Wardens while the Squad is on its way to an incident. In such circumstances, the Leader should arrange for his men to change into protective clothing at some convenient empty house or other building. The men's personal clothing, preferably tied up in a box, should then be left in charge of the police, or a Warden or other responsible person. Arrangements should be made for its return to the Rescue Depot, or the Depot Overseer should be notified so that he can have the clothing collected.

Alternatively, the Leader may notify the Depot Overseer and, in the interests of speed, arrange for his own Squad to return to the Depot and for a fully equipped substitute Squad to be sent direct from the Depot to the scene of the incident.

Whether protective clothing is put on at the Depot or en route, it should not be completely buttoned up until the men reach the contaminated area.

APPROACHING THE GASSED AREA

Wherever possible, the Squad must approach a gassed area from *upwind*. The Leader and the Driver must, therefore, consult the Gas Reconnaissance Agent, Warden, or the Incident Officer, to insure that the Rescue Squad will arrive at the incident "with the wind," and that the vehicle and equipment are not exposed to liquid contamination.

In approaching closely to the gassed or contaminated area, the Leader must continually watch for the presence of gas, and, as soon as he suspects gas, he must instruct his men to put on their gas masks.

PRECAUTIONS IN RESCUE OPERATIONS

Gas bombing alone may not require rescue work, but, if gas is present at an incident involving casualties or people trapped, rescue operations must, so far as possible, be carried out from the *upwind side of the damage*. When rescue work must be done *downwind of* liquid gas, the men must wear gas masks and, if necessary, protective clothing. Short rest periods should be provided at frequent intervals at a point upwind of the gassed area.

Victims being extricated must be protected as much as possible. It is essential to reach a trapped person's face as soon as possible and put a gas mask on him after his eyes are flushed out and his face washed. If blister (vesicant) gas is present, victims must be protected against contamination; if they are already contaminated, they must be extricated in such a way as to avoid making their condition worse and contaminating the rescuers.

When possible, grossly contaminated clothing should be removed promptly and placed where it will not contaminate others.

NONPERSISTENT GAS

Nonpersistent gas should not cause serious inconvenience to rescue workers equipped with gas masks. At ground level, the gas is likely to disperse fairly quickly, but it may remain for some time in basements and other enclosed spaces and under debris. For work in such places, therefore, gas masks may have to be kept on for a considerable time, and, because of the greater strain on the men, more frequent relief may be necessary than would otherwise be required. Induced ventilation (Chapter VI) may be useful in clearing pockets of nonpersistent gas.

When rescue personnel have to break into basements into which poison gas has not penetrated, great care must be taken to prevent the entry of the gas. This may be accomplished in one of several ways; for example:

1. By leaving the final act of breaking in until the nonpersistent gas has sufficiently dispersed, provided the time is not too long and it is certain that gas has not already penetrated the basement.

2. By rigging up a temporary gas lock with wet blankets around the place where entry is to be made. This takes time and is not always practicable.

3. By blowing clean air to the trapped persons by means of a long hose and portable air compressor. The air must be drawn from a gas-free area, and the hose pushed through as small a hole as possible and taken well inside the basement. This procedure is appropriate when the basement itself is substantially undamaged and the trapped persons are uninjured. If it is used to bring clean air to wounded persons trapped under debris, precautions must be taken to prevent an air blast that will stir up large quantities of dust or otherwise injure the casualties. This can be assured by placing the end of the delivery hose in a tin can over which an ordinary cloth sack is tied.

PERSISTENT GAS

When blister (vesicant) gas is present, rescue operations are likely to be slower and more difficult than when nonpersistent gas is present. In exceptional cases, members of a Rescue Squad may have to take some risk of contamination if urgent action is necessary to save life. Normally, however, the personnel will be dressed in full protective clothing before entering the contaminated area. Before beginning rescue work, the Leader should obtain from the Incident Officer or Gas Reconnaissance Agent some idea of the extent of the contamination. The Decontamination Unit of the Public Works Service should deal with the contamination at the earliest possible moment so as to facilitate the movement and work of the Rescue Squad. Hoods should be worn only if the men have to work in heavy concentrations of blister (vesicant) gas vapor or where there is risk of liquid blister (vesicant) gas dripping on the men from debris, etc., overhead.

Contaminated areas should be entered as little as possible and contaminated debris handled only when no other approach to the casualty is possible. Debris splashed with liquid gas is likely to be contaminated underneath as well as on top, especially if it has been hosed down.

WORKING IN PROTECTIVE CLOTHING

As protective clothing is practically airtight, it prevents the escape of natural heat and evaporation of perspiration from the body. Therefore wearing of protective clothing (particularly with the hood) is possible only for short periods.

When wearing such clothing, workers must limit their activities to essential tasks. When not actually at work, they must rest (if possible out of the contaminated area), so that the clothing can be unfastened and the body aired. All work should be done slowly and steadily; any attempt to rush or run will make the wearing of the clothing almost impossible.

Leaders must be sure that men in full protective clothing work in limited shifts (e. g., for about 30 minutes at a time), and that, in the intervals between work, the reliefs rest outside of the contaminated area with the clothing loosened and the hood and gas mask off.

Protective clothing, if not contaminated, must be returned to the Rescue Depot as soon as the duty period is over; it must not be left on the vehicle or taken home.

SUMMARY OF PROCEDURE AT GAS INCIDENTS

Personnel must:

1. Approach incident from upwind side, whenever possible.
2. If necessary, wear full protective clothing and gas masks, properly adjusted.
3. Stand by until Leader has examined situation and consulted Gas Reconnaissance Agent, Incident Officer, or Warden as to extent of contamination. If none of these is present, Rescue Leader must determine extent of contamination himself so far as he is able.
4. Whenever possible, avoid walking over contaminated ground.
5. So far as possible, avoid handling contaminated debris.
6. Avoid handling casualties if gloves are contaminated. Where possible, only uncontaminated helpers should undertake this work.
7. Supply trapped persons with gas masks as soon as reached.
8. Avoid letting gas into undamaged basements, etc., where people may be trapped in space free from gas.
9. Avoid working until the point of collapse.
10. When incidents are downwind of gas, all men should take a short rest at frequent intervals.
11. Avoid working in the hood unless it is essential.
12. Go to previously designated cleansing facility as soon as relieved from duty.

PART V

Rescue Service Training

CHAPTER XIX

Organization of Training

The Rescue Service personnel must be trained in the art of extricating trapped persons from beneath structural debris. This is a new technique, and British experience has shown that thorough training saves many lives; untrained personnel may labor for days and recover only dead bodies. Rescue workers must be trained individually in principles, technique, and use of equipment, and Squad members must also be trained to work together as a team.

Advanced training in field care and transportation of the injured is necessary. Rescue workers are usually the first to reach trapped casualties, and they must know how to render essential first aid.

It is the purpose of the Office of Civilian Defense to establish a pattern for Rescue Service training and to provide basic technical information. Local authorities should not hesitate to amplify or adapt these suggestions to meet the special conditions existing in their own communities, so long as prerequisites for appointment to the Rescue Unit, set forth in Regulations No. 3 (Revised August 1943) of the U. S. Citizens Defense Corps, are met.

LOCAL RESPONSIBILITY FOR TRAINING

The local Chief of Rescue Service is responsible, under the Commander, for training of the Rescue Service. He and his assistants are to obtain their training at Regional and State schools. They may also avail themselves, through the State Rescue Officer, of the assistance, advice, and cooperation of the Rescue Section of the Medical Division, U. S. Office of Civilian Defense.

GENERAL TRAINING PROGRAM

Training of Rescue Squads must be thought of in terms of a long-range and continuous program. The Rescue workers must know the techniques of rescue work and its possible hazards. The training is similar in many respects to training in mine rescue.

Training in rescue work may be conveniently divided into four stages. It is not always necessary that one stage be finished before the next stage is undertaken; individual and Squad training may be carried on concurrently.

1. Individual Training.—This is composed of two parts: (a) *Pre-induction training.*—Basic instruction in organization of Civilian Defense, first aid, and gas defense required for enrollment in the Rescue Unit of the Citizens Defense Corps; (b) *In-service training.*—Basic training in rescue techniques, equipment and duties, and advanced training in field care and transportation of the injured.

2. Squad Training.—The members of the Squad are trained to work together as a team, and they practice with other Squads of the Rescue Service.

3. Combined Training.—Rescue Squads are trained to cooperate with other Civilian Defense services in proceeding to and rendering service at incidents.

4. Interservice Training.—Training of Rescue Squad personnel in the duties and techniques of other Civilian Defense services, such as demolition and decontamination, which they may be called upon to perform.

PRE-INDUCTION TRAINING

While pursuing the basic training required for enrollment in the Citizens Defense Corps, the student should be registered as a trainee in order to be entitled to use, for training purposes, equipment issued by the Office of Civilian Defense and in order to be eligible for medical care, disability benefits, and assistance if injured while undergoing training.

Pre-induction training required for appointment to the Rescue Unit is set forth in OCD Regulations No. 3 (Revised August 1943), and consists of the following courses:

First Aid, 20 hours (except that the 15-hour Bureau of Mines course may be substituted when given by a certified Bureau of Mines instructor).

Basic Civilian Defense, 5 hours.

Gas Defense, 2 hours.

These courses are to be given by qualified instructors under the direction of the local Commander. They are not specialized rescue courses. After satisfactory completion of this training and enrollment in the Citizens Defense Corps as a member of the Rescue Unit, the worker undertakes in-service training under the direction of the Chief of Rescue Service.

CHAPTER XX

Pilot, Regional, and State Schools and Local Training

Two Pilot Rescue Schools have been sponsored by the Office of Civilian Defense in cooperation with the U. S. Bureau of Mines. They were established for the purpose of instructing State Chiefs of Rescue Service and their deputies and local Chiefs of Rescue Service of large cities in rescue techniques and in instructional methods.

Regional and State Rescue Schools are established, with the assistance of the Office of Civilian Defense, for training local Chiefs of Rescue Service and Squad Leaders. Local Chiefs of Rescue Service are expected to establish programs for training and drilling individuals and squads in their communities, with the assistance and cooperation of the State Rescue Officers.

LOCAL TRAINING

Since the work of rescue is done by the members of Rescue Squads, any successful plan of training must be concerned first with the instruction of the individual Squad member. Suitable places for holding classes and drills must be selected. These will ordinarily be the Rescue Depots. The need for rescue equipment in conducting training should be kept in mind when Rescue Depots are established. Certain Depots, however, may not be suitable for classroom instruction, and arrangements should be made in such cases for classes to be conducted at other Depots or suitable facilities.

It is not necessary that *individual training* be given to the Squad as a unit. All competent Squad Leaders are not necessarily good instructors. Squad Leaders with special teaching ability should attend a State School and may then give the *individual training* to members of the Rescue Service at a central point. *Squad training*, on the other hand, is best given by a Leader to his own Squad at its own Depot.

Small communities, where local facilities are limited, may be able to arrange, through the State Rescue Officer, for the visit at convenient times of qualified instructors to train Rescue Service volunteers. Established stations and facilities of the U. S. Bureau of Mines which give training in disaster work should be utilized in local

training when possible. Rescue trucks and cars such as are used by this Bureau should also be utilized if available.

Mining and other industries are well organized for rescue work and have capable instructors. The "Smoke Eaters" organization consists of trained mine-rescue men. Such sources of qualified instructors should be tapped where they are available.

THE TRAINING SCHEDULE

In order to maintain the Rescue Service continually in a state of preparedness, constant training and drill are necessary. The training program must, therefore, be carefully worked out to maintain interest and to accomplish as much training as possible in the limited time which volunteers can afford.

After pre-induction training has been completed and the new enrollees are organized into Squads and assigned to Depots, the Squads should meet regularly, as frequently as possible, for systematic instruction and practice under the supervision of the Leader according to a schedule prepared by the local Chief of Rescue Service. Squad members with special skills may be used to assist in the instruction of other members.

The local Chief of Rescue Service and the Squad Leader should arrange the training program. At the beginning, two periods a week are desirable. These may be reduced to one per week or every two weeks as experience and facility increase. Squad meetings and drills should be held at least twice a month.

CHAPTER XXI

Individual Training

As stated in Chapter XIX, the *individual training* undertaken by the members of the Rescue Service embraces a first (basic) stage required for enrollment in the Rescue Unit of the U. S. Citizens Defense Corps and a second or advanced stage of in service training which deals with rescue problems and techniques.

The subjects to be covered in the *individual training* are listed in the schedule below. The list of subjects does not necessarily indicate the order in which they should be taught. Lectures should be interspersed with demonstrations; instruction on field care and transportation of the injured should be started early and might well occupy one hour of each session until the course is completed. Training in each detail should be by explanation, demonstration and then execution by trainees under supervision.

RECOMMENDED INDIVIDUAL TRAINING FOR RESCUE SERVICE

Subject	*Hours of instruction*
Pre-induction (27 hours):	
Basic Civilian Defense	5
First Aid	20 or 15
Gas Defense	2
In Service Training Introductory (5 hours).	
Rescue Service: Functions, Development, Organization and Control	1
Recommended Equipment	1
Ventilating and Lighting Equipment	1
Selection and Care of Equipment	1
Organization of Training and Schools	1
Training in Use of Respiratory Protective Devices (13 hours).	
Types of Gases Other than War Gases	1
Methods of Detecting Common Gases	1
Devices for Detecting Common Gases (lecture and practice)	2
Methods of Protection Against Common Gases	1
The All-Service Gas Mask (lecture and practice)	2
The Hose Mask or Supplied-Air Respirator (lecture and practice)	2
The Self-Contained Oxygen Breathing Apparatus (lecture and practice)	4

Subject	*Hours of instruction*
Training in Use of Explosion Preventive Devices (7 hours).	
Explosibility of Common Gases	1
Devices for Illumination	1
Devices for Ventilating Confined Places	1
Practice in Use of Protective Equipment Against Common Gases	4
Training in Use of Special Working Equipment (8 hours).	
Ropes, Knots, and Lashings (lecture and practice)	2
Sheerlegs, Derricks and Rigging (lecture and practice)	2
Lifting Appliances (lecture and practice)	2
Oxyacetylene Cutting (lecture and practice)	2
Rescue Operations (2 hours).	
Action on Alerts and at Incidents; Incident Officers	2
Rescue Techniques (20 hours).	
Damage to Buildings and other Facilities	2
Damage to Utility Services	1
Rescue by Stages and Location of Casualties (lecture and practice)	3
Reconnaissance in Rescue (lecture)	1
Rescue in Presence of Common Gases (lecture and practice)	2
Shoring and Demolition (lecture and practice)	3
Rescue by Clearance of Debris	1
Rescue by Trenching and Tunneling	1
Rescue by Trenching and Tunneling (practice)	3
Salvage of Property and Valuables	1
Rescue in Presence of War Gas	2
Practical Problems in Rescue (6 hours).	
Field Care and Transportation of the injured (see OCD Manual) (24 hours).	

In arranging for instruction of Rescue Service personnel in subjects relating to other civilian protection fields, the Chief of Rescue Service should request the assistance of chiefs of other appropriate services. The Chief of Emergency Medical Service will arrange instruction in field care and transportation of the injured; the Senior Gas Officer will arrange for instruction in decontamination and protection against war gases; the Fire Chief will provide instruction in control of incendiaries and other fire fighting techniques. Arrangements should be made with the Transport Officer for Drivers to receive special instruction in night and blackout driving.

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CHAPTER XXII

Squad Training

The fundamental requirements for speedy, safe, and efficient rescue operations during air raids or other disasters are: (1) efficient organization, (2) adequate and proper equipment, and (3) proper technique in performing the work. The purpose of squad training is to insure that men are properly prepared for emergency work and accustomed to working together in a Squad and in cooperation with other Rescue Squads.

SQUAD TRAINING PROGRAM

In order to carry out *Squad training* successfully, a program must be arranged with due regard to the time which the men are able to devote to the work, the equipment available, and the facilities of the Depot.

The program should be as varied as possible. The drills and practices in any extended period should not be limited to one branch of rescue work or type of practical operation. They should range over all classes of rescue problems. Exercises should be as realistic as possible, and the Squad should go through entire procedures in detail.

A drill period or lecture should not last more than 45 minutes and should be followed by a short period of questions and discussion. Many subjects and exercises cannot be completed in this period of time; it is better to devote several drill periods to a single subject than to give hurried, inadequate instruction. Two hours is as long as volunteers can ordinarily be expected to devote continuously. Daylight exercises should be held before exercises are undertaken in the dark. As the Squad becomes more expert, the members should be required to work with the added handicaps of respiratory protective equipment, protective clothing, etc.

Unless the staged rescue incidents approach the conditions of real incidents, they do not provide the Squad members with the proper background for tackling an actual rescue operation. Certain precautions are to be observed in staging rescue incidents for training purposes.

1. While much useful instruction can be imparted by means of diagrams and models, they cannot take the place of rescue exercises which approximate the conditions and circumstances that exist at a real incident.

2. The type, quantity, and position of debris should resemble that which may be found at a demolished building.

The following suggested program of drills and exercises for *Squad training* is based largely on British experience. It may serve as a useful guide for training.

Drills and Exercises for Squad Training

Subject	Description
Emergency First Aid	
Loading Drill	Stowing and checking of equipment in vehicles. Unloading vehicles. Laying out equipment for inspection.
Action on Warning Signals	Mobilization of Squads at Depot. Action on arrival at Depot. Assembly of equipment. Squads (with personal equipment) proceed in orderly manner to shelter.
Action on Dispatch	Action of Squad (including Leader) on being dispatched to an incident.
Action on Arrival at Incident	Parking of vehicle. Contact with Warden and Incident Officer. Leader's reconnaissance. Allocation of duties to squad members, etc.
Use of Respiratory-Protective Equipment.	Practice in use of self-contained oxygen-breathing apparatus, gas masks, and "hose masks" both in open air and in a smoke chamber.
Use of Gas-Detecting Equipment	Practice in use of flame safety lamp; combustible-gas detector, and carbon monoxide indicator.
Reconnaissance and Search for Casualties.	Detailed reconnaissance. Orderly movement. Searching and calling for casualties. Safety of personnel.
Care and Use of Ropes	Uncoiling, coiling, and stretching. Control and handling of ropes. Hauling on ropes. Reeving tackle. Practice in the rope work necessary for the assembly of derricks, trestles, and tripods.
Use of Ladders	Unloading, carrying, placing in position, halving and putting together, extending, ascent, lashing and manning the ladder, Descent and lowering. Methods of strengthening for special purposes.
Ladder Drill	Fireman's lift; sliding stretcher.
Rope Techniques	Various methods of using ropes to lower a stretcher from a height, etc.
The Applications of Shores	Practice in hoisting prepared shores into position; strutting, wedging, and securing, taking down again and stowing for re-use; practice in full-scale shoring problems.

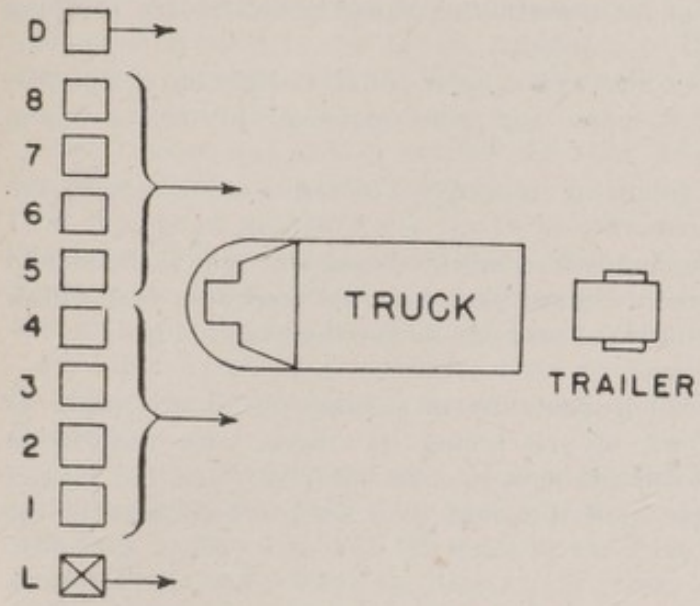
Drills and Exercises for Squad Training[1]—Continued

Subject	Description
Shoring (Needling, Underpinning, and Bracing).	Practice in shoring, needling, underpinning, and bracing walls.
Use of Standing Derrick and Swinging Jib.	Various methods of assembly, using catsheads, blocks and tackle for rescue work.
Use of Sheerlegs for Rescue Work	Various methods of using sheerlegs, blocks and tackle for rescue work.
Use of Tripod	Using tripod (3 poles) with block and tackle for rescue work through manhole.
Use of Staging and Bridges for Rescue Work.	Various methods of erecting and using staging for handling stretchers from heights. Various methods of improvised bridging over gaps and craters.
Lifting Exercises	Raising and picking up heavy weights, using jacks, timbers, etc. Extrication of casualties.
Handling Light Debris and Extrication of Casualties.	Systematic procedure; protection of casualties, team work in the lifting of wreckage; chain work in clearing debris; use of the services of unskilled bystanders.
Tunneling	Driving tunnel, timbering, precautions against collapse, use of debris baskets and chain work, signaling and listening for casualties.
Wall Breaking	Breaking through wall, floors, girders, roofs, etc., to obtain access to trapped persons.
Demolition	Methods to eliminate risk of loss of life through structural collapse; the collapse of dangerous chimneys, overhanging ruins, unseated floors and other dangerous structures; improvised scaffolding, staging, etc.
Use of Ventilating Equipment	Methods of ventilation for removing noxious gases.
Incendiary Bomb (and Smoke) Drill	Use of stirrup pump, working in smoke chamber, extinguishing fires.
Decontamination	Team work on decontamination procedures such as unloading of materials and equipment, handling of equipment, bleach, etc., roping off, erection of public warning notices.

[1] For drills in emergency field care and transportation of the injured, see OCD Publication 2215 on this subject.

DRILL IN LOADING AND UNLOADING TRUCK AND TRAILER

As a part of Squad Training, a standard form of equipment inspection drill including the loading and unloading of the truck and trailer should be practiced so that these operations can be performed rapidly and in an orderly manner.



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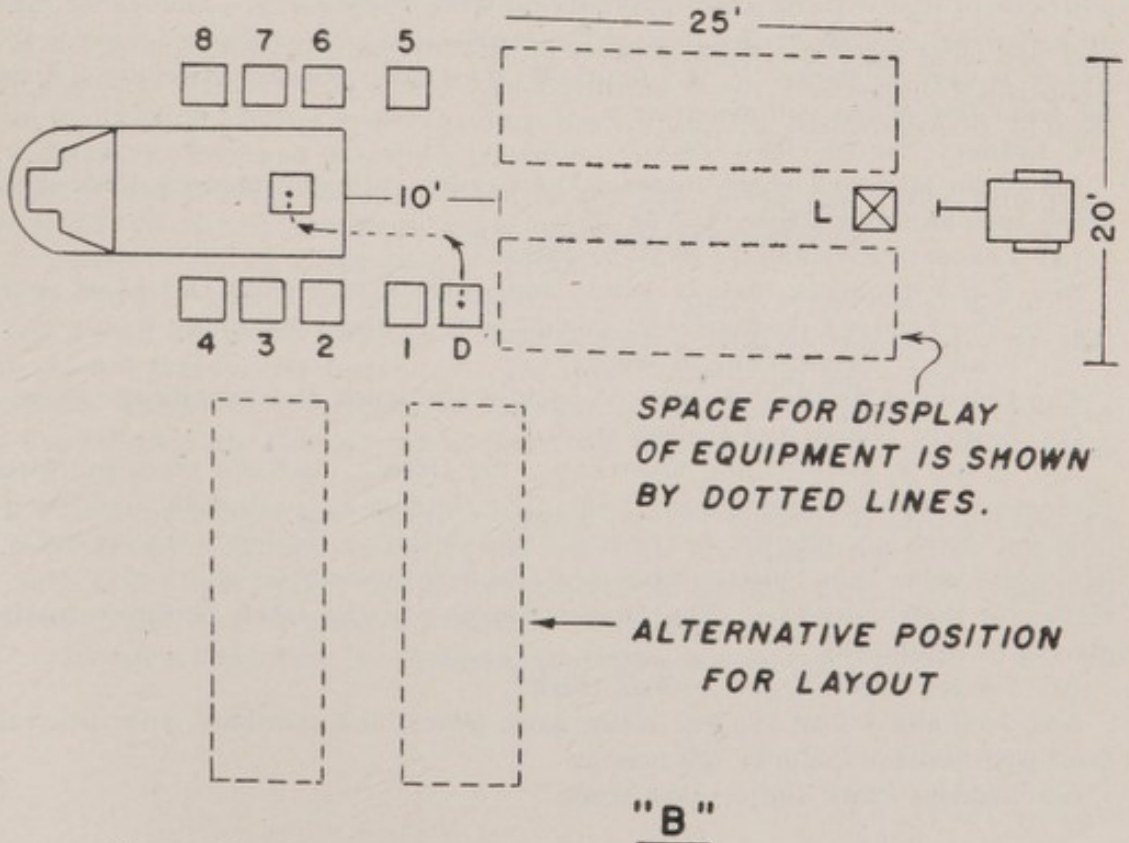

"B"

FIGURE 39.—Diagram of loading and unloading truck and trailer.

Loading and Unloading Truck

A satisfactory outline of activities or duties in connection with the loading and unloading of the truck and trailer is shown diagrammatically in figure 39.

The letters and numbers designating the various members of the Rescue Squad are as follows: The leader is designated L, the driver D; the Assistant Leader is given the number 1, and the remaining squad members are assigned numbers from 2 to 8.

The Squad members wear their protective hats, personal lighting equipment, and carry their respirators, flashlights, and other personal protective equipment as the occasion demands.

Referring to figure 39, the following procedure is followed in connection with the loading of the truck.

The Leader should give all commands in a military manner; that is, he should give first a preparatory command to place each man in readiness and follow this command after an interval of 1 or 2 seconds by the final command.

1. Leader: "Fall in."

The Rescue Squad members fall in centrally in a single file in the order of their numbers, two paces in front of and facing the truck, with the Driver on the extreme left two paces from the next man on his right, and the Leader on the extreme right two paces from the next man on his left, who is the Assistant Leader (see "A," fig. 39).

2. Leader: "Count off."

The man (Assistant Leader) at the right of the Squad (looking toward truck), calls "One," and the remainder of the Squad follow in order, counting "Two," "Three," etc., with the Driver calling "Driver" as the final call.

3. Leader: "Stand by truck."

The men divide and take their positions, four on each side of the truck, as shown in "B," figure 39, Nos. 1 and 5 acting as checkers and taking their positions in line with the rear of the truck, three paces away. The leader takes up a central position at the rear of the truck, about 25 or 30 feet away. If a trailer is used as shown in "A," figure 39, the Driver stands between No. 1 and the front line of the equipment area.

4. Leader: "Squad—load truck."

After the standard short interval the Leader calls the men by numbers to act in turn as follows (see "B," fig. 39):

(a) Leader: "Five and 6—unhitch trailer."

Nos. 5 and 6 unhitch trailer, double away with it to a point two paces to the rear of the Leader's position, and double back to their positions.

(b) Leader: "Driver—mount truck."

The Driver opens the rear door or back of the truck and mounts the truck.

(c) Leader: "Three and 4—load truck."

Nos. 3 and 4, assisted and directed by the Driver, load and place protective equipment, such as respiratory protective equipment, protective clothing (if occasion does not require wearing it), gas-detecting equipment, and lighting equipment other than electric cap lamps and flashlights, after which Nos. 3 and 4 return to their positions. The Driver remains in the truck to direct further placing of equipment.

(d) Leader: "One, 6, and 7—load truck."

Nos. 1, 6, and 7 load shovels, picks, axes, levers, and crowbars, and then take their positions for the next assignment.

(e) Leader: "Two and 8—load truck."

Nos. 2 and 8 load jacks, levers, and bricklayer's tools, then return to their positions.

(f) Leader: "One, 5, 6, and 7—load truck."

Nos. 1, 5, 6, and 7 load wheelbarrow, ladder, rope tackle, crosscut saw, wedges, packing pieces, stretchers, and carpenter's tools, then return to their positions.

(g) Leader: "One—inspect tools."

No. 1 inspects the tools in box, closes and locks box, and puts the key in his pocket or gives it to the Driver according to the adopted procedure. He then returns to his position in the rear of the truck.

(h) Leader: "Final Inspection."

The Leader and Driver inspect the load, after which the Leader returns to his place in the rear of the truck.

If the squad members are not to be transported in the truck to an incident, the Driver closes and fastens the door of the truck and then returns to his position beside No. 1. If the men are to be transported in the truck, the Driver leaves the door open and returns to his position beside No. 1.

In either event, on completion of the loading of the truck and after the men, including the Driver, are all in position in the line, the Leader announces, "truck loaded."

If a trailer is not used and the squad members are transported in the truck to an incident, they take their places in the truck on command from the Leader, who may or may not take his place in the front seat with the Driver, after the Driver closes and fastens the door of the truck.

If a trailer is used, the door of the truck is left open or closed, depending on whether or not the men are to be transported.

5. On the command, "unload truck," given by the Leader, the order of the foregoing procedure is reversed, each movement being again carried out as and when the Leader calls the men by numbers.

Loading and Unloading Trailer

If a trailer is used the men remain in position after the truck is loaded (see "B" fig. 39), though for equipment practice this is not necessary. When desirable to practice loading and unloading the trailer, the following drill is held:

1. Leader: "Five and 6—attach trailer."

Nos. 5 and 6 leave their positions in the line, bring the trailer into place behind the truck, and after fastening it, return to their positions.

2. Leader: "Driver, 3 and 4—load trailer."

The Driver takes a standing position in the rear of the truck, while Nos. 3 and 4 load the trailer; all then return to their positions. The Driver inspects the loaded trailer and fastenings. He then follows the procedure previously described governing the closing of the door of the truck, according to whether or not the men are transported in the truck, and returns to his position beside No. 1.

3. The Leader then announces "truck and trailer loaded;" the members of the Rescue Squad take their places in the truck for transportation to an incident, if such is the case; after this the Driver closes the door of the truck and the procedure outlined in the truck drill is completed.

In unloading the trailer the foregoing procedure is reversed.

CHAPTER XXIII

Combined and Interservice Training

COMBINED TRAINING

Combined training is the responsibility of the Commander of the Citizens Defense Corps and his Chiefs of Service. It has as its purpose the development of effective integration of the activities of all protection services at an incident. Integration involves an understanding on the part of each service of the problems and procedures of other services, and a knowledge of the duties and responsibilities of Incident Officers.

This type of training can be conducted by demonstrations on models and diagrams, followed by incident exercises in which two or more services participate. Such exercises should be graded progressively upward, starting with simple problems involving only small units of two separate services and progressing to full scale, complicated problems which require the participation of all the protection forces of the community. All such exercises should be carefully planned in advance, observed by a qualified referee, and carefully analyzed in retrospect.

The Rescue Service should train with the Air Raid Warden, Emergency Medical, Fire, Emergency Public Works, and Emergency Utilities Services.

Combined training exercises should emphasize the importance of the Incident Officer as the direct representative, at the scene, of the Commander.

The exercises should include problems which require maintaining contact with the Incident Officer's Post and coordination between services.

In combined training exercises, Squad Leaders must be taught how to use to the greatest possible advantage the full resources of leadership, specialized technical training, manpower, and equipment of the Squad personnel. The exercises should include the use of several Rescue Squads at an incident. This will involve problems of deployment of men and equipment, regrouping of technically trained men, pooling of equipment, and maintenance of liaison between working groups. Such exercises will serve to develop discipline in the Rescue Service.

INTERSERVICE TRAINING

In order to conserve manpower, members of Units of the Citizens Defense Corps should broaden their knowledge and fields of usefulness by taking training in the fundamental techniques and methods of related services. This may be accomplished through a program of interservice training.

Such training for rescue workers might appropriately include courses and exercises in demolition and clearance, decontamination, road repair, and fire defense. The drills in Chapter XXII may be used by the Rescue Service in providing interservice training for personnel of other services.

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Appendix A

Excerpt From Administrative Order No. 23

ESTABLISHMENT OF UNITED STATES CITIZENS DEFENSE CORPS

Pursuant to authority granted by Executive Order No. 8757, dated May 20, 1941, as amended, creating the Office of Civilian Defense, the Director of Civilian Defense (hereinafter referred to as the "Director") hereby confirms the establishment, within the Office of Civilian Defense, of:

United States Citizens Defense Corps.

1. INSIGNIA OF OFFICE OF CIVILIAN DEFENSE AND ITS STAFF CORPS.

A. Basic Insigne.

The basic insigne prescribed for the Office of Civilian Defense shall consist of the letters "CD" in red centered in a white equilateral triangle embossed on a circular field of blue.

B. Staff Corps Insignia.

The prescribed insignia for the Staff Corps of the Office of Civilian Defense shall consist of the basic insigne of the Office of Civilian Defense, which, when used by the Staff Corps of the Office of Civilian Defense in its Washington Office or Regional Offices, shall be superimposed on the letters "US," and when used by members of State Defense Councils or Local Defense Councils, or persons on the staff of such Councils or of the local Volunteer Offices of the Office of Civilian Defense, shall be placed immediately above a rectangle embodying the name, or abbreviation of the name, of the particular state.

C. "CD" Insignia.

The use of the letters "CD" alone and not in connection with prescribed insignia of the Office of Civilian Defense or any Branch or unit thereof is prohibited. All prior orders or instructions relative to the use of the letters "CD" alone on arm bands or other articles of identification, whether for temporary use by trainees or any other groups of persons, are hereby cancelled and rescinded.

II. UNITED STATES CITIZENS DEFENSE CORPS.

A. Units.

The United States Citizens Defense Corps (hereinafter referred to as the "Defense Corps") consists of units composed of enrolled members in (1) the protective services engaged in civilian defense now established and hereinafter specified, (2) additional protective services engaged in civilian defense from time to time established as units of the Defense Corps pursuant to order of the Director, (3) services related to the protective services engaged in civilian defense now or hereafter established as such by order of the Direc-

tor, including Chaplains. The protective services engaged in civilian defense now established are:

(1) Staff Corps.
(2) Air Raid Warden.
(3) Auxiliary Police.
(4) Auxiliary Firemen.
(5) Fire Watchers.
(6) Demolition and Clearance Crews.
(7) Road Repair Crews.
(8) Rescue Squads.
(9) Decontamination Squads.
(10) Medical Corps.
(11) Nurses' Aides Corps.
(12) Drivers Corps.
(13) Messenger Corps.
(14) Emergency Food and Housing Corps.
(15) Utility Repair Squads.
(16) Instructors.

B. INSIGNIA.

(1) The insignia prescribed for the units of the Defense Corps designated in (2) to (14), inclusive, of Section A are as specified in the official publication of the Office of Civilian Defense entitled "United States Citizens Defense Corps," a copy to which is attached to and made a part of this Order.

(2) The prescribed insignia for the Staff Corps of the Defense Corps shall be a blue five-pointed star above the letters "CDC" in red, centered in a white equilateral triangle embossed on a circular field of blue, which, when used by the Staff Corps of the Defense Corps in the Washington Office and the Regional Offices of the Office of Civilian Defense, shall be superimposed on the letters "US," and when used by the Local Staff Corps of the Defense Corps in the communities, shall be placed immediately above a rectangle embodying the name, or abbreviation of the name, of the particular State.

(3) The prescribed insigne for Utility Repair Squads shall be a pair of pliers, jaws closed, handles extending downward, in red, centered in a white equilateral triangle embossed on a circular field of blue.

(4) The prescribed insignia for Chaplains, analogous to Chaplains' insignia used by the United States Army, shall be: (a) Chaplains—Christian: A Latin cross, in red, centered in a white equilateral triangle embossed on a circular field of blue; (b) Chaplains—Jewish: Six-pointed star centered above the Tables of the Law in silhouette, in red, centered in a white equilateral triangle embossed on a circular field of blue.

(5) The prescribed insigne for Instructors in the Defense Corps shall be a white equilateral triangle embossed on a circular field of blue, in which triangle there shall be, in red, an inverted equilateral triangle above which shall be a falling bomb, to the left of which shall be a chemical retort and to the right of which shall be a flame. Such insigne for Instructors may be used on lapel buttons, pins, and other means of identification, but not on arm bands or brassards. An Instructor may wear an arm band or brassard only if member of another unit of the protective services engaged in civilian defense, in which case he may wear only the arm band or brassard of such unit.

(6) Additional insignia may be prescribed from time to time by regulations or orders of the Director with respect to additional units of the Defense Corps.

(7) Use and wear of prescribed insignia shall be governed by regulations to be issued by the Director. It shall be unlawful for any person to use or wear such insignia except in accordance with the regulations, rules, orders and instructions of the Director.

C. ORGANIZATION.

The organization of the Defense Corps is set forth in the official publications of the Office of Civilian Defense entitled "Staff Manual—United States

Citizens Defense Corps," and "The Control System of the Citizens Defense Corps," copies of which publication are attached to and made a part of this Order, and shall so continue subject to further order of the Director.

D. SUPERVISION.

The Defense Corps is under the supervision of the Office of Civilian Defense, Protection Branch, which is headed by an Assistant Director appointed by and responsible to the Director.

E. DISTRIBUTION AND USE OF SUPPLIES AND EQUIPMENT OF THE OFFICE OF CIVILIAN DEFENSE.

In order to attain maximum efficiency in the use and preservation of supplies and equipment of, or under the control of, the Office of Civilian Defense which are loaned to communities pursuant to Executive Order No. 9088 dated March 6, 1942 and Regulations No. 1 of the Office of Civilian Defense, it is hereby ordered, in accordance with Section 7 of said Regulations No. 1, that (1) such loaned supplies and equipment shall be distributed by such communities, directly or indirectly, only to enrolled members of the Defense Corps or to members of the local police department or fire department, all in accordance with instructions of the Commander of the local Citizens Defense Corps, and (2) all such loaned equipment shall be used only by enrolled members of the Defense Corps or by members of the local police department or fire department; provided, however, that eligible applicants for membership taking prescribed and approved courses of training or instruction for membership in the Defense Corps may receive, use or wear such loaned supplies or equipment if and to the extent and under the conditions permitted by rules, regulations or orders issued by the Director. Any community which distributes any such loaned articles of personal wear to any person not an enrolled member of the Defense Corps or a member of the local police department or fire department, or a trainee, to the extent permitted as aforesaid with respect to trainees, or not in accordance with the instructions of the Commander of the local Citizens Defense Corps, or which permits any person not such a member or trainee to use or wear any such loaned supplies or equipment, or which fails promptly to recall any such loaned supplies or equipment from any person whose membership or training status in the Defense Corps has been suspended or terminated by order of the Local Defense Council or the Director, as provided in Regulations to be issued by the Director, shall be deemed to have violated its Agreement (OCD Form No. 501) with the Director pursuant to which such supplies and equipment were loaned; and in such event the Director may proceed to recall all or any part of such equipment and supplies of any character loaned to such community.

Appendix B

OPERATIONS LETTER NO. 133

ORGANIZATION OF RESCUE SERVICE

In accordance with the program announced in Operations Letter No. 102, the following organization is outlined for the Rescue Service:

1. *Responsibility.*—Rescue in burning buildings must continue to be the responsibility of the organized Fire Services. The recovery of survivors and dead trapped under the structural debris of demolished buildings is the responsibility of the Rescue Service of the U. S. Citizens Defense Corps.

2. *Rescue Section of the Medical Division.*—An engineer officer of the U. S. Public Health Service, formerly of the Bureau of Mines, has been designated

Chief of the Rescue Section of the Medical Division, U. S. Office of Civilian Defense.

3. *Regional Rescue Officers.*—Other mining engineers with rescue experience and commissioned in the U. S. Public Health Service will be assigned as Rescue Officers to the Civilian Defense Regions in the target areas to assist the States and local communities in organizing and training the Rescue Service.

4. *Cooperation with Emergency Medical Service.*—At the State and local levels, the Rescue Service is to be independent of the Emergency Medical Service but will cooperate with it closely. The Rescue Service is responsible for extricating trapped persons and cooperates with mobile teams of the Emergency Medical Service in handling casualties in the field.

5. *State Chiefs of Rescue Service.*—State Directors of Civilian Defense are urged to appoint mining or civil engineers familiar with mining or construction work as Chiefs of Rescue Service of their States. It is the responsibility of the State Chief of Rescue Service to assist local Directors of Civilian Defense in selecting qualified safety engineers or structural experts trained in rescue work to serve as local Chiefs of Rescue Service.

6. *Local Chiefs of Rescue Service.*—The local Chief of Rescue Service, or his deputy, is a member of the staff at the Control Center; during an air raid or other wartime disaster, he is responsible under the Commander for dispatching Rescue Squads to incidents. He is responsible for the training and discipline of Rescue Squads.

The Chiefs of the Emergency Medical and Rescue Services, through coordinated action in the Control Center, should dispatch an Express Party (one Rescue Squad, one ambulance, one Mobile Medical Team, and one passenger car or station wagon) to an incident when trapped persons are reported in a demolished building. Dispatch of additional units is to be deferred until requested through the incident officer or warden by the respective leaders of the Mobile Medical Team or Rescue Squad at the incident.

7. *Rescue Squads.*—The personnel of the Rescue Service is best recruited from workers in the building and demolition trades, mechanics, mine workers, petroleum industry workers, and tunnel workers in the heavy construction industry. The volunteer office should assist in recruitment. The members of the Rescue Service are to be organized into squads of ten, of whom one is to be the Leader, one Assistant Leader, and one Driver of the truck. The Driver should be responsible also for the rescue equipment of the squad.

It is desirable that the Fire Service maintain its own professional rescue squads for duty in connection with fires. Where an extensive volunteer rescue organization has been developed under the Fire Service, this should be transferred to the Rescue Service.

Where Stretcher Teams are constituted of persons especially fitted for rescue work, it may be desirable to effect a transfer of such persons to the Rescue Service. At the same time, an effective Stretcher Team organization, as described in Operations Letter No. 134, must be maintained and strengthened as an essential part of the Emergency Medical Service. Local Commanders will direct local Chiefs of Service in effecting such reorganization and transfers as may be necessary.

8. *Heavy Rescue Equipment and Personnel.*—There is no reason for a distinction between light and heavy Rescue Squads. The Rescue Service will call upon the Emergency Public Works Service when special technical personnel and extra heavy equipment such as cranes, tractors, compressors, etc., are required for the rescue of trapped persons. For this purpose, the Chief of Emergency Public Works Service will maintain an inventory of all such equipment in the commu-

nity in the possession of private contractors and utility companies, as well as governmental departments.

9. *Rescue Depots.*—The Rescue Squads are to be based in Depots, such as garages, sheds, or other suitable places where training may be carried on and equipment stored and from which Squads can be dispatched to incidents. Rescue Depots are best located away from obvious target areas, some being located on the periphery of the community. An average of one for each 50,000 population is recommended in the target areas. Each Depot should have a complement of thirty rescue workers organized into three Squads which rotate on periods of first call. The Chief of Rescue Service should designate the Leader of one of these Squads as Depot Overseer, who will have supervisory responsibilities for the Depot. He will maintain rosters and inventories, arrange training schedules and Squad rotation, and will report to the Chief of Rescue Service on Depot activities.

10. *Unit Strength.*—The number of Rescue Squads and Rescue Depots required for each vulnerable community in the target area is dependent not alone upon the population but upon the square miles over which the community is spread and the relative number of multi-storied buildings of all kinds, particularly those constructed of stone, brick, or concrete. For those sections of a community in which the houses are largely of frame construction or of the one-story type, fewer Rescue Squads are needed because trapped persons will be fewer and their extrication less difficult.

For sections of a community in which the buildings are predominantly of stone, brick, or concrete and steel construction, the number of Rescue Depots will depend on local conditions and need not exceed one to 50,000 residents. A variation above or below these recommendations may be warranted by geographic considerations and population density and must, therefore, be left to the discretion of the Commander of the Citizens Defense Corps and the local Chief of Rescue Service. The national program contemplates an establishment of about 1,000 Depots and a full Rescue personnel of 30,000 organized into 3,000 Squads. It is preferable to have a few well trained Squads which can serve as a nucleus for subsequent expansion of the Rescue Service if required, than to organize a large number for which training and equipment cannot be provided locally.

11. TRAINING.

a. *Pre-induction.*—Before appointment to the Rescue Unit, trainees must have satisfactorily completed the training prescribed in Regulations No. 3, U. S. Citizens Defense Corps. This includes a basic course in first aid which may be either the Red Cross "First Aid for Civilian Defense" (20 hours—Instructor's Manual ARC 1055), or the Bureau of Mines standard course (15 hours).

b. *Post-induction.*—After taking the required oath of the U. S. Citizens Defense Corps and being enrolled, members of the Rescue Unit are to continue to receive special technical training essential for rescue workers. At first this should consist of a two-hour period twice weekly. The drills and practices in any one week should not be limited to one type of rescue work. They should range over all classes of rescue problems and include practice in advanced first aid and handling of the injured as well as rescue techniques.

Rescue Techniques.—This will include training and practice in reconnaissance, tunnelling, shoring, etc., in accordance with the outline of exercises and drills given in the Technical Manual for the Rescue Service.

Emergency Field Care and Transportation of the Injured.—This is advanced training and practice in emergency field care and transportation of civilian war casualties. A training manual for this purpose will be ready for distribution shortly. The instruction should be given by a physician or other qualified person

recommended by the Chief of Emergency Medical Service. Instruction may also be given by the Chief of the Rescue Service or by a Rescue Squad Leader who has attended a Rescue Training School.

The lives of the victims of an air raid or other wartime disaster depend in large part upon the training and skill of the Leaders and other members of the Rescue Squads. The technique which they employ in extricating trapped persons from under structural debris and the manner in which they handle the severely injured determine the chances of survival.

It is the intention of the U. S. Office of Civilian Defense to establish two pilot Rescue Service Training Schools in collaboration with the Bureau of Mines, one at Pittsburgh, Pa., and the other near San Francisco, Calif., at which appropriate technical instruction will be given to Chiefs of the Rescue Services of the States and larger cities in target areas. They will in turn be able to establish Regional or State Schools for the training of local Chiefs of Rescue Service. Local Chiefs of Rescue Service, with the aid of instructors whom they select, will carry on instruction in rescue work at local schools.

Appendix C

Operations Letter No. 128

(Supersedes Operations Letter No. 46)

HOW TO PROTECT YOURSELF AGAINST WAR GAS

1. Stay indoors.—A tightly closed room affords protection against war gas. All windows and doors should be tightly shut, and blankets (to be soaked with water) or cardboard should be kept in readiness to cover and seal shattered windows. Choose a room on an upper floor if possible; most war gases are heavier than air, although they may be carried up with air currents.

2. If caught outdoors in a gas attack, get out of the area at once.—Look down and shield your eyes with your arms. Do not worry about any brief vapor exposure to which you may be subjected. The danger from this source is not great.

3. Prompt action will avoid serious effects.—If you know or suspect that you have gotten any of the gas on your person or clothing, do not go hunting for a casualty station or gas cleansing station and expect someone else to help you. *Knock on the first door* you come to, and take whatever steps are necessary. Self-aid is the quickest and safest way.

4. This is what you should do. This routine should be memorized so it will be done automatically in an emergency:

(*a*) *Remove shoes and outer clothing and drop them outside the house*, in a covered can if available. Do not touch this clothing again except with sticks or gas-proof gloves. Do not cling to false modesty. To enter a house with contaminated clothing endangers everyone in it.

(*b*) *Get to a bathroom, kitchen, or laundry room as fast as possible.*

(*c*) *If your eyes have been exposed to liquid gas or spray*, flush them immediately. Plain water out of a faucet, shower-head, canteen, or douche bag will do, but a lukewarm dilute solution of bicarbonate of soda (heaping tablespoonful in a quart of water) is even better, if it is handy. Let anyone nearby help you.

(*d*) *If drops of liquid blister gas have splashed the skin*, you can prevent serious burns by adequate cleansing. Promptly blot up the liquid with pieces of cleansing tissue, cloth, or a handkerchief, which should be disposed of carefully in order that it cannot contaminate anyone else. Then sponge the skin briskly with laundry bleach containing sodium hypochlorite, if it is at hand, and rinse off under the shower or in a tub. A thorough bath with a vigorous lathering is the final step, *which should never be omitted.* Dry the skin by patting. Do not rub. Dress in whatever clean clothing you can get. If blisters develop, you should seek medical advice.

(*e*) *If your nose and throat feel irritated*, snuff and gargle with a dilute solution of bicarbonate of soda. If your chest feels heavy and oppressed, if you have any trouble breathing, or if smoking becomes distasteful, lie down immediately and stay perfectly still until you can be taken to a doctor. Do this even if you feel fine otherwise.

5. Remember: Cleanse yourself quickly and calmly. Follow the instructions of your air-raid warden.

Appendix D

ELECTRICAL HAZARDS IN AIR RAIDS

In the performance of their duties members of the Citizens Defense Corps may be brought into situations where electric cables or wires have fallen to or near the ground as the result of an air raid or other disaster. It is therefore imperative that they understand exactly what to do in such cases.

The voltage, and consequent danger, of a wire cannot be judged by its size or general appearance. Even if it could, it should be remembered that a comparatively low voltage, under certain conditions, is sufficient to cause death. *Always assume that any wire or cable is a "live" and dangerous one* until it has been proved safe.

INITIAL PRECAUTIONS

Immediately upon the discovery of such a situation, a guard should be arranged to keep people and traffic away from the area containing the fallen wires. The area should be roped off and barricaded if necessary. If possible, have the current shut off.

As soon as possible, the Control Center should be notified of the incident.

Until an experienced utility repair crew arrives on the scene and makes necessary repairs, no one should be allowed to touch or handle a fallen wire. No amateur electricians should be allowed to "try a hand" at such a time.

MOVING A "LIVE" WIRE

If it should be necessary to move a wire to effect rescue work or to perform other emergency tasks, use a long *dry* stick, a *dry* board, a *dry* rope, or other material which will not conduct electricity. *Use no metal whatever. Be especially careful in your selection of the object to be used.* Many materials commonly thought to be nonconductors will, under certain conditions, carry an electric current. For example, even apparently dry clothing may have a sufficient residue of salt from perspiration to conduct an electric current.

If necessary to move the wire, *be very sure that the ground you stand on is perfectly dry.* If at all possible, secure a large *dry* board and stand on this while moving the wire with a nonconducting object.

Never attempt to climb poles, towers, or other structures to investigate an electrical hazard. And never permit yourself or others to work around fallen wires while wearing a metal helmet. *Metal helmets must be removed* before any attempt is made to move, inspect, or repair electric wires.

Should Fire Guards or others be fighting a fire where such wires are located, they must remember—*water is a conductor of electricity.* Live wires in water or upon wet surfaces may energize the surrounding ground or pavement; thus it is extremely dangerous to use water under such conditions. If essential to continue the use of water to extinguish a fire in such an area, it is necessary to keep people still farther away from the fallen wires than under ordinary conditions.

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In this connection, remember that *a stream of water is a conductor.* Standing on the ground and holding a wet hose from which a stream of water is playing on a live wire, the worker becomes *a part of the circuit, and the entire current may flow through his body.*

RESCUE WORK

Attempting to rescue a person from contact with a live wire is very dangerous. Do not touch any portion of the person's body until he has been freed from contact with the wire—and do not touch the wire with your hands or body. Do not attempt to cut the wire unless you have been trained and authorized to do such work, and have the proper equipment.

Experience has shown that even the insulated coverings of wires afford little, if any, protection. Heavy rubber gloves may give some protection, but even these should not be depended upon.

In some cases it may be possible to free a victim by pulling upon his clothing, but this is dangerous because of the possibility previously mentioned—that the clothing may conduct electricity because of a residue of salt from perspiration. The safest step is to have the current shut off, if at all possible, before attempting a rescue.

In cases of electrical shock, when breathing has stopped, artificial respiration should be administered immediately after the victim has been removed from the live wire (using the prone pressure method described in the Red Cross *First Aid Text-Book* and in the Office of Civilian Defense *Handbook of First Aid*). The victim should be given medical attention as soon as possible.

Finally, it must be remembered that it is not possible to suggest any one method of rescue which is safe and foolproof under all circumstances. It is only through special training, the use of adequate equipment, and the exercise of great care that a rescuer may be assured of safety from electrical hazards.

SUMMARY

Briefly, the steps to follow in dealing with electrical hazards are:

1. Arrange to keep people away from the wire and surrounding area until the repair crew arrives, or the current can be shut off.
2. Notify the Control Center as soon as possible.
3. If a person is in contact with a live wire, try to have the current shut off before attempting a rescue.
4. Do not attempt to cut a wire unless you have received training, have been authorized to do such work, and have the proper equipment.
5. If it is necessary to move a wire or a victim before the current is shut off, use an object of nonconducting material—do not touch the wire or person with your hands or body.
6. Be sure the ground you stand on is perfectly dry.
7. Give artificial respiration, if indicated, immediately after the person has been freed from the wire; secure medical assistance as soon as possible.

These suggestions are for the guidance of civilian defense workers who are not technically trained and who have not had previous experience in handling electric service facilities. Members of the Utility Repair Unit, of course, should be governed by safety codes developed by the industry.

It is important that all civilian defense workers whose duties may in any way involve the handling of electrical hazards be given special training on this subject by a representative of the local electric industry.

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