CHAPTER I

RESCUE

A. FIVE PHASES OF RESCUE

Rescue work is normally conducted under adverse conditions, often complicated by darkness. No hard, fast rules can be devised to give leaders sure guidance on how to tackle every job. By proceeding in phases according to a regular plan, leaders are less likely to overlook important points. Every rescue operation should adhere to the five phases of rescue, as closely as possible.

It is of the utmost importance that all rescue workers observe all safety rules when carrying out a rescue mission. Safety rules apply not only to the rescuers, but to the casualties as well. Teams of two or more personnel should accomplish search operations.

1. PHASE I

Phase I begins at the occurrence of the incident and may continue for several minutes to several hours, depending upon the size and severity of the emergency.

Reconnaissance in rescue may be defined as the collection of all relevant information and the systematic search of the incident site.

There are two aspects of reconnaissance. The first part is “information gathering”. The following information should be sought:

- How many and the probable location of persons trapped?
- What is the nature and extent of damage?
- How many of and what are the construction types of the compromised structures?
- Have utilities been compromised (gas, electric, water, sewer, etc.)?
- Are there any hazardous materials involved?
- In the event of a suspected terrorist incident, is there the potential for secondary explosive devices, or the presence of chemical or biological weapons of mass destruction?

Sources that should be used to gather the above information are as follows:

- Fire, rescue or law enforcement personnel already on the scene
- Civilian by-standers
- Casualties

The aforementioned will probably be the first people on the scene and could, in many cases, provide good information. One of the best sources of information is the casualties themselves, provided they are stable enough to give reliable information.

The second aspect of reconnaissance is “observation”. This is the responsibility of the team leader. The team leader should not rely solely on information gathered from by-standers, but should dispatch reconnaissance teams into the affected areas as soon as possible to conduct a damage assessment and size-up. Additionally, the team leader should establish the Incident Command System (ICS) immediately upon arrival. A command post should be set up outside the immediate hazard area and the team leader now becomes the Incident Commander (IC). With the command post established and the IC in place, field personnel have a known location to transmit and receive information. By establishing ICS early in the incident, the potential for rescuers to “free-lance” is minimal, thus reducing the possibilities for injury and allowing the IC to maintain control over the entire event. Failure to do so may have catastrophic results, and at the least, adversely affect the efficiency of the rescuers.

The IC should also be cognizant of other factors that may affect the planning and implementation of rescue operations, including weather, time and day of the occurrence, and whether the structure(s) have a high life hazard potential (school, churches, hospitals, etc.). Considering all these factors and information gleaned from civilians and obtained from rescue personnel, the IC can begin to plan and implement an organized rescue effort and request additional resources as required.

2. PHASE II

Phase II may occur simultaneously with Phase I or may begin shortly after the incident occurs. Phase II focuses on the rescue and removal of surface casualties with approximately fifty percent of all victims of collapsed structures falling into this category. Most surface casualties can be easily reached and removed to an area of relative safety. Most injuries occur from falls or being struck by falling objects. “Good Samaritans” acting prior to the arrival of organized rescue efforts will have accomplished the removal of the majority of the
victims. Rescue and removal of surface casualties is of paramount importance in the initial phases of the incident, as this does the most good for the most people with the least expenditure of resources.

3. PHASE III

Phase III begins following the arrival of organized teams and the establishment of ICS. Teams utilizing the information obtained during Phases I and II operations will begin systematic searches that include void exploration using techniques such as voice hailing, dog search and the use of sophisticated technical search gear, cameras and electronic listening devices to pinpoint victim locations. Victims who are “lightly” trapped comprise approximately thirty percent of structural collapse victims and are usually entrapped by building contents and a lot of structural components.

4. PHASE IV

Phase IV involves the rescue of victims who are entrapped or entombed in void spaces and require the use of highly trained rescuers and a myriad of specialized equipment. Operations conducted during Phase IV may require any or all of the following:

* Additional technical search techniques with listening devices and cameras to pinpoint the victim(s) exact location and position.
* Breaching and breaking of structural components to permit void entry or rescue utilizing pneumatic, hydraulic, or electric breakers or drills.
* Shoring utilizing timbers, steel or commercial devices to safeguard rescuers and victims from material shifts or aftershocks.
* Cutting and/or burning to gain access or effect rescue using a wide variety of manual and power tools and oxy-acetylene, exothermic and plasma torches.
* Selected debris removal may be accomplished manually or with the use of heavy equipment such as front-end loaders, track-hoes, heavy wreckers and cranes.

Phase IV operations require strict adherence to all safety procedures and should be conducted under the direct supervision of a structural engineer. These are EXTREMELY DANGEROUS OPERATIONS!

Victims heavily entombed or entrapped comprise only 15 to 20 percent of all casualties but require a much higher percentage of resources and manpower utilization to effect their rescue.

5. PHASE V

Phase V operations commence when all likelihood of finding and rescuing viable victims has been exhausted. During Phase V, general debris removal is accomplished and the removal of deceased victims completed. Heavy equipment is used extensively and debris is routinely broken down into smaller, more manageable pieces.

B. STRUCTURAL MARKINGS

The Federal Emergency Management Agency (FEMA) has developed a system of structural markings to be utilized during search and rescue operations. This marking system includes distinct and separate designs for structural hazard, search, assessment and victim location.

Structural/Hazard Evaluation Marking:

The Structural Specialist (or other Task Force member as appropriate) will outline a 2’ x 2’ square box at any entrance accessible for entry into the structure. The box will be made with international orange spray paint.

It is important that an effort is made to mark all normal access points to ensure that approaching task force personnel can identify it has been evaluated and discern its condition.

Specific markings will be made inside the box to indicate the condition of the structure and any hazards AT THE TIME OF ASSESSMENT.

An arrow will be placed next to the box indicating the direction of the safe entrance, if the markings must be made somewhat remote from the safe entrance.
BUILDING MARKING SYSTEM

The various markings are as follows.

The structure is accessible and safe for US&R operations. Damage is minor with little danger of further collapse.

Structure is significantly damaged. Some areas are relatively safe, but other areas need shoring, bracing or debris removal. Structure may be completely pancaked.

Structure is not safe for US&R operations and may be subject to sudden additional collapse. Remote search may proceed at significant risk. If operations are undertaken, safe havens and escape routes should be created.

Arrow located next to the marking box indicates the direction of safest entry to the structure.

Indicates a HAZMAT condition exists in or adjacent to the structure. Personnel may be in jeopardy. Consultation should be made with HAZMAT Specialist.

STRUCTURAL/HAZARDS EVALUATION MARKING (continued)

The following information: TIME, DATE, and SPECIALIST ID will be noted outside the box at the upper right-hand side. The information will be placed using lumber crayon or carpenter’s chalk.

As additional assessments are made during the mission, a new TIME, DATE, and SPECIALIST ID marking will be made below the previous entry, or a completely new marking box made if the original information is now incorrect.

The following is an illustration of a completed Structure/Hazards Evaluation mark.

06/26/03 1440 Hrs
HM - natural gas
NC-TF1

The depiction above indicates a safe point of entry exists above the marking. The single slash indicates the structure may require some shoring before continuing operations. The assessment was made June 26, 2003 at 2:40 p.m. There is an indication of natural gas in the structure. The evaluation was made by North Carolina Task Force 1.

It should be noted that this building would not be entered until the natural gas was turned off. When this is done the HM should be lined out and a new time should be noted, or an entirely new mark should be made.
VICTIM LOCATION MARKING SYSTEM

During the search function it is necessary to identify the location of potential and known victims.

The amount and type of debris in the area may completely cover or obstruct the location of any victim.

The victim location marks are made by the search team or others aiding the search and rescue operations whenever a known or potential victim is located and not immediately removed.

The victim location marking symbols should be made with orange spray paint (using line marking or “downward spray cans”) or orange crayon.

The victim location marking symbols and numbers of victims, if known, must be kept on the developing site map during the search of the structure or area.

Victim Location Marking System:

A large (approx. 2 ft.) “V” is painted near the location of the known or potential victim. An arrow may need to be added to the “V” pointing towards the victim’s location if not clearly visible or is not immediately nearby where it is practical to paint the “V”. Paint the US&R Task Force identifier in the top part of the “V”.

Paint a circle around the “V” when the location of a potential victim has been confirmed either visually, vocally, or by hearing sounds that would indicate a high probability of a victim. Confirmation may be done when the victim is initially located or after partial debris removal. Confirmation may be done with the use of specialized search equipment such as video or fiber optic cameras. A canine alert will normally be considered an unconfirmed victim location, even if the alert is confirmed by a second canine. However, such a confirming canine alert should be interpreted as a highly probable victim location.

Paint a horizontal line through the approximate middle of the “V” when the victim is confirmed to be deceased.

Paint an “X” through the confirmed victim symbol after all victims have been removed from the specific location by the marking. Paint new victim symbols next to the additional victims that are later located near where the original victims were removed (assuming the original symbol has been “X”ed out).
SEARCH ASSESSMENT MARKING

A separate and distinct marking system is necessary to conspicuously denote information relating to the victim location determinations in the area searched.

This marking system is designed to be used in conjunction with the Structures/Hazard Evaluation marking system.

The Search Specialist will draw a 2' x 2' "X" with international orange spray paint.

The "X" will be constructed in two operations; with one slash drawn upon entry into the structure (or void), and the second crossing slash drawn upon exit.

The markings are as follows:

- Single slash is drawn upon entry and indicates a search is in progress.
- Crossing slash drawn upon exit from the structure.
- TOP QUAD - Time and date the task force personnel left structure.
  06/26/03 1440 hrs
- LEFT QUAD - Task Force Identifier.
  NC-TF1
- RIGHT QUAD - Personal Hazards
- BOTTOM QUAD - Number of Live and Dead victims still inside (0 = no victims)
  2 - LIVE
  3 - DEAD

SURVIVAL RATES

Heavily entrapped or entombed victims present a significant challenge to rescuers with respect to time. Eighty percent of these victims are considered salvageable. Viable victims will be rescued within the first 24 hours. After the first day, survivability drops markedly with each passing day.

It is not unheard of to find victims alive after seven days, but their long-term survival is questionable. Factors such as exposure to environmental extremes, dehydration, crush syndrome, and underlying medical problems all work to the detriment of the victim. Crush syndrome has been called "The Grateful Dead Syndrome" because victims are often conscious, alert, smiling and thanking their rescuers, only to die several days later in the hospital. The deaths are usually attributed to the release of toxins into the body when crushed body parts are freed and circulation resumes. Researchers and physicians continue to explore new treatment methods for these victims; however, time remains the most important factor for survival.
C. TYPES OF COLLAPSE AND FORMATION OF VOIDS

When buildings are damaged and walls and floors collapse, they may form various types of voids. These voids provide areas of safety for casualties. It is important that rescuers learn to recognize such voids as an aid to search operations.

1. Lean-To Type Collapse

When floor supports fail in a building, floors and roof may drop in large sections. If these sections remain in one piece and are supported on one side but collapse or sag on the other, they form a lean-to-type of collapse. (See Fig. 1-A)

![Lean-To Floor Collapse](image)

Lean-To Floor Collapse
Figure 1-A

2. V-Shape Collapse

When main support walls on the inside of a building give way, or when the weight of heavy loads such as furniture or rubble and debris are concentrated near the center of a floor, a V-type collapse may occur. (See Fig. 1-B)

![V-Shape Floor Collapse](image)

V-Shape Floor Collapse
Figure 1-B
3. Pancake Floor Collapse

The weakening or destruction of weight-bearing walls may cause the floors, and possibly the roof, to collapse, one on top of each other. This is referred to as a pancake type collapse. (See Fig. 1-C). Heavy furniture may support a collapsed section of floor or wall, creating voids. Persons may be trapped between the layers of the "pancakes".

Pancake Floor Collapse
Figure 1-C

D. TEMPORARY SHORING

A temporary shore, as applied to rescue work, is a series of timbers erected in order to strengthen and prevent further collapse of any part of a building. Rescue workers should not spend time in erecting elaborate shoring but devote time only to such temporary shoring as may be necessary to meet urgent requirements. The purpose of shoring is to make buildings safe to carry on rescue work, to prevent further injury to casualties, and to eliminate danger to the public through collapse of buildings into streets or other public places.

It is essential that all shoring be properly secured in position. Wedging and tightening of shores must be done gently and gradually to prevent further shock to the structure.

Shores may vary in type according to requirements but fall into three main classes: raking shores, flying shores, and dead or vertical shores.

1. Raking shore

This shore is used to prevent a wall or upright part of a building from bulging or falling. (See Fig. 1-D on page 8). The principal parts include wallplate, raker, and soleplate. When used against a bulging wall, it should be backed with spacers to provide continuous bearing.

Method of Erecting A Raker Shore

Rakers are best formed with square timbers. The number of rakers required is dependent upon the height of the wall to be supported and the number of floors carried by the wall. There should be one raker for each floor carried by the wall. The raker should be set so its foot forms a 60 to 90 degree angle with the ground.

A cleat should be nailed to the wallplate where it meets the head of the raker. The wallplate must be secured to prevent sliding upward as the rakers are tightened. In a masonry wall, the plate may be secured by extending cleats through an opening or by nailing it into a window frame. If there are no openings, secure the wallplate by using nails in the mortar joints. Caution should be used when nailing into a masonry wall needing shoring.

On soft ground the bottom of the hole for the soleplate should be sloped toward the unsafe wall to provide the proper angle. On hard ground the soleplate should be built up to the required angle and spiked or wedged.
After placing the cleat on the wallplate and securing it to the wall, raise the top of the raker to the cleat, and place the foot on the soleplate. Gently force the whole structure into place. Nail a cleat to the soleplate at the foot of the raker to secure it.

Struts or braces may be fixed to the wallplate and raker to prevent movement.

Raking Shore  
Figure 1-D

2. Flying Shore

This shore is used between a sound wall and a damaged wall. The shored wall gives support through the shore to the damaged wall. Two types of flying shores are used. (See Fig., 1-E A&B on page 9)

The principal parts of the flying shore include a horizontal beam, wallplates, and struts. Other items necessary for the erection of the flying shore are cleats, wedges, and straining pieces.

Method of Erection

Lay the flying shore out on the ground for proper measurement prior to erection. Cleats are nailed to wallplates first - one pair to support the horizontal beams, the others to support the struts. Struts should be set at a 45 degree angle or less to the horizontal beam. They are kept apart by the straining pieces. The length of the straining pieces is determined by the length of the horizontal beam.
A

NOT TO EXCEED 25 FEET

B

NOT TO EXCEED 20 FEET

Flying Shores
Figure 1-E
After all measurements have been made and all materials cut, wall plates are put in place and held while the horizontal beam is placed on the center cleats. The plates are tightened by double wedges (one driven in from each side of the horizontal beam) inserted between the end of the beam and the wallplate. (Note: Wedges should be used on the sound wall side.)

Next, the struts are placed in position. Place struts on the damaged wall first. (These may be held by the straining pieces.) The struts are now placed on the sound wall and tightened by use of double wedges.

The wall plates should have continuous bearing. This can be accomplished by use of packing between the wall and wallplate. Flying shores should be placed along a wall at intervals of eight to twelve feet, depending on the situation, type of wall, and the amount of damage. They are not recommended for use between two walls separated by more than 25 feet.

3. Dead or Vertical Shore

A dead or vertical shore is an upright timber used as a temporary column or post. The purpose is to take the weight of a damaged floor or to support a beam. (See Fig. 1-F) It is also used when an opening must be cut in a wall and vertical support is required.

Principal parts of the dead or vertical shore are the sole piece, headpiece, and strut. Other items used are braces and wedges.

Method of Erecting

The solepiece is laid down in position, taking care that it is placed on a solid foundation. The headpiece is held in position, and struts are then placed upright between the headpiece and the solepiece and are securely wedged by a pair of double wedges inserted between the strut and the solepiece. Wedges should be driven until they just take the weight and no more.
If possible, struts should be made of square timbers. It is difficult to estimate what load a strut must carry and to gauge what load the strut timber can support. However, in strutting a damaged building, the following principles apply:

a. For a given-size timber, the shorter the strut, the greater the load it can carry.
b. A strut of square cross section is stronger than a rectangular one of the same cross-section area.
c. The ends of struts should be cut squarely to fit the soleplate and headpiece.
d. Struts should always be larger than needed.

The soleplate should be made as long and as wide as practicable to spread the load over a sizeable area. When struts are used on upper floors, the strutting should be repeated on floors below so that the load will rest on a firm foundation.

The headpiece should be at least as large as the end of the strut. The load being supported will be a determining factor here. The span between struts should be kept as small as possible because the smaller the span, the stronger the shore will be.

Strutting Openings

When walls near window and door openings are unsafe, they are to be shored up. When the head or sills of such openings are damaged, it is a sensible precaution to strengthen the opening by strutting. (See Fig. 1-G A&B)

When strutting openings, sufficient room must be left between struts for a casualty to be brought through or to enable a rescue to be effected.

Strutting Window Openings
Figure 1-G
E. CRIBBING

Cribbing is used widely in many forms of rescue. It may be found in many varied forms or fashions. Cribbing is usually soft wood (Yellow Southern Pine or Douglas Fir) and the most readily available sizes are 4" x 4' x 24". Other sizes may be used, depending on the task to be accomplished.

Its capacity is based on the crossgrain bearing area of the system. Pressures ranging from 200 to 1000 PSI may vary, depending on the type of wood being used. 500 PSI is the most commonly used pressure for calculation purposes.

Placement and construction is of critical nature. Crib blocks should be inset at least the minimum width of the crib block being used (Example 6" x 6' x 24" or 8" x 8' x 24") to assure a slow crushing failure. Maximum height of a crib system is 3 times the dimension of the crib itself.

Cribbing may take shape in various forms, as mentioned above. Some examples would include:

• Box cribbing, 2x2 (Figure 2, page 13)
• Cross-tie cribbing, 3x3 (Figure 3, page 13)
• Box cribbing with wedges, (Figure 4, page 13)
• Triangle or Trapezoid cribbing, (Figure 5, page 13)
• Parallelogram cribbing, (Figure 6, page 13)