NFPA 1670

Standard on

Operations and Training for Technical Search and

Rescue Incidents

2004 Edition

This edition of NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, was prepared by the Technical Committee on Technical Rescue and acted on by NFPA at its November Association Technical Meeting held November 15–19, 2003, in Reno, NV. It was issued by the Standards Council on January 16, 2004, with an effective date of February 5, 2004, and supersedes all previous editions.

This edition of NFPA 1670 was approved as an American National Standard on January 16, 2004.

Origin and Development of NFPA 1670

The responsibility for NFPA 1470, *Standard on Search and Rescue Training for Structural Collapse Incidents*, 1994 edition, was transferred to the Technical Committee on Technical Rescue, which prepared a proposed new NFPA 1670, *Standard on Operations and Training for Technical Rescue Incidents*. That document incorporated the scope of NFPA 1470, expanding it to include identifying and establishing levels of functional capability for safety and effectively conducting operations at technical rescue incidents.

This second edition of NFPA 1670 represents a complete revision and incorporates the reorganization of the chapters to comply with the new NFPA *Manual of Style*. The title of the document has been changed to "*Standard on Operations and Training for Technical Search and Rescue Incidents*" as a result of a petition by the Technical Committee to the Standards Council to include "search" as part of the scope of the Committee. The search element has also been added to each of the disciplines within the document.

The committee wishes to acknowledge the valuable contributions of George Howard to the origin and development of this document. Mr. Howard was working as a police officer for the New York and New Jersey Port Authority when he perished in the line of duty on September 11, 2001, at the World Trade Center at the age of 44. He was a 16-year veteran of the department and a founding member of its elite emergency services division and was awarded the New York Police Department's Medal of Valor for rescuing children trapped in the World Trade Center during the 1993 bombing. Mr. Howard was a charter member of the NFPA Technical Rescue Technical Committee, on which he represented the Nassau County (NY) Fire Academy. His enlightened influence and hard work shall always be a part of this document.

Technical Committee on Technical Rescue

Leslie D. English, *Chair*
Wackenhut Services, Inc., AL [U]

Donald C. Cooper, *Secretary*
Cuyahoga Falls Fire Department, OH [U]
Rep. National Rescue Consultants

Robert N. Aguiluz, The Roco Corporation, LA [M]
Barbara A. Beers, Seattle Fire Department, WA [E]
Joseph C. Burris, North Carolina Department of Insurance, NC [E]
H. K. "Skip" Carr, H. K. Carr & Associates Inc., NJ [SE]
Rep. International Society of Fire Service Instructors
James R. Engram, Colorado Springs Fire Department, CO [U]
Steve Fleming, Poudre Fire Authority, CO [U]
James A. Frank, CMC Rescue, Inc., CA [M]
Tim Gallagher, Bryan, TX [SE]
Carl Goodson, Action Training Systems, Inc., WA [M]
Rep. International Fire Service Training Association
Ihor M. Holowczynsky, Rescue Tech, Inc., Canada [SE]
Steve Hudson, Pigeon Mountain Industries, Inc., GA [M]
Billy M. Lee, Jr., Champion International Paper Company, FL [U]
Robert J. Masonis, Sr., California Office of Emergency Services, CA [E]
Christopher J. Naum, L.A. Emergency Management & Training, NY [SE]
John P. O'Connell, Collapse Rescue Systems Inc., NY [SE]
Robert E. Rhea, Fairfax County Fire and Rescue, VA [U]
Louis Robinson, South Charleston Fire Department, WV [U]
Brian Rousseau, State of New York, NY [E]
Chase N. Sargent, Virginia Beach Fire Department, VA [E]
Robert P. Thornton, City of Mobile Fire Department, AL [U]
Rep. University of South Alabama (CERT)
William J. Troup, U.S. Fire Administration, MD [SE]
William H. Weems, Safe State Program, AL [SE]
Ernest R. (Richey) Wright, Wright Rescue Solutions, Inc., FL [SE]

Alternates

Francis J. Brennan, Seattle Fire Department, WA [E]
(Alt. to B. A. Beers)
Michael G. Brown, Virginia Beach Fire Department, VA [U]
(Alt. to C. N. Sargent)
Joseph M. Clark, Houston Fire Department, TX [SE]
(Alt. to T. Gallagher)
Fred J. Jackson, Cuyahoga Falls Fire Department, OH [U]
(Alt. to D. C. Cooper)
Jay McCallum, Chicago Fire Department, IL [U]
(Alt. to R. P. Thornton)
Loui (Clem) McCurley, Pigeon Mountain Industries, Inc., CO [M]
(Alt. to S. Hudson)
Frank E. Florence, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on technical search and rescue techniques, operations, and procedures to develop efficient, proper, and safe utilization of personnel and equipment.

NFPA 1670
Standard on
Operations and Training for Technical Search and Rescue Incidents
2004 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex K lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex K.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall identify and establish levels of functional capability for conducting operations at technical search and rescue incidents while minimizing threats to rescuers.

1.1.2* The requirements of this standard shall apply to organizations that provide response to technical search and rescue incidents including those not regulated by governmental mandates.

1.2* Purpose.

1.2.1 The purpose of this standard shall be to assist the authority having jurisdiction (AHJ) in assessing a technical search and rescue hazard within the response area, to identify the level of operational capability, and to establish operational criteria.

1.2.2 The functional capabilities of this standard shall be permitted to be achieved in a variety of ways.

1.3 Equivalency.

Nothing in this standard shall be intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety in place of those prescribed by this standard, provided technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents,* 2002 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* 2002 edition.

NFPA 1521, *Standard for Fire Department Safety Officer,* 2002 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System,* 2002 edition.

2.3 Other Publications.

2.3.1 ANSI Publication.

American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/GCA G7.1, *Commodity Specification for Air.*

2.3.2 U.S. Government Publication.

U.S. Government Printing Office, Washington, DC 20402.

U.S. Department of Transportation, *First Responder Guidelines.*

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Shall. Indicates a mandatory requirement.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.

3.2.5 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Acceptable Entry Conditions. Conditions that must exist in a space to allow entry and to ensure that employees can safely enter into and work within the space.

3.3.2 Alternate Air Source. A secondary air supply source system that involves an alternate second-stage regulator provided by either a separate dedicated second-stage or a multipurpose second-stage regulator coupled with a buoyancy compensator inflator valve.

3.3.3 Anchor Point. A single, structural component used either alone or in combination with other components to create an anchor system capable of sustaining the actual and potential load on the rope rescue system.

3.3.4 Anchor System. One or more anchor points rigged in such a way as to provide a structurally significant connection point for rope rescue system components.

3.3.5 Ascending (Line). A means of safely traveling up a fixed line with the use of one or more ascent devices.

3.3.6 Ascent Device. An auxiliary equipment system component; a friction or mechanical device utilized to allow ascending a fixed line. [**1983:**1.3]

3.3.7 Assessment Phase (Size-Up). The process of assessing the conditions, the scene, and the subject's condition and ability to assist in his or her own rescue.

3.3.8 Auxiliary Equipment. System components that are load-bearing accessories designed to be utilized with life safety rope and harness including, but not limited to, ascending devices, carabiners, descent control devices, rope grab devices, and snap-links. [**1983:**1.3]

3.3.9* Avalanche. A mass of snow — sometimes containing ice, water, and debris — that slides down a mountainside.

3.3.10* Belay. The method by which a potential fall distance is controlled to minimize damage to equipment and/or injury to a live load.

3.3.11 Bell-Bottom Pier Hole. A type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a bell shape.

3.3.12 Benching or Benching System. A method of protecting employees from cave-ins by excavating the side of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

3.3.13 Bend. A knot that joins two ropes or webbing pieces together.

3.3.14 Body Recovery. An operation involving the retrieval of the remains of a deceased victim, but in no case a living person.

3.3.15 Cave-In. The separation of a mass of soil or rock material from the side of an excavation or trench, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

3.3.16 Collapse Zone. See 3.3.102, Rescue Area.

3.3.17 Compass. A device that uses the earth's magnetic field to indicate relative direction.

3.3.18 Competent Person. One who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. [**1006:**3.3]

3.3.19* Confined Space. A space that is large enough and so configured that a person can enter and perform assigned work, that has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, and pits), and that is not designed for continuous human occupancy.

3.3.20 Confined Space Rescue Service. The confined space rescue team designated by the AHJ to rescue victims from within confined spaces, including operational and technical levels of industrial, municipal, and private sector organizations.

3.3.21 Confined Space Rescue Team. A combination of individuals trained, equipped, and available to respond to confined space emergencies.

3.3.22 Cribbing. Short lengths of timber/composite materials, usually 101.60 mm ×101.60 mm (4 in. ×4 in.) and 457.20 mm ×609.60 mm (18 in. ×24 in.) long that are used in various configurations to stabilize loads in place or while load is moving.

3.3.23 Critical Angle. An angle of 120 degrees or less created between two rope rescue system components wide enough so as to create excessive force on the anchor points to which they are attached.

3.3.24 Descending (Line). A means of safely traveling down a fixed line using a descent control device.

3.3.25 Descent Control Device. An auxiliary equipment system component; a friction or mechanical device utilized with rope to control descent. [**1983:**1.3]

3.3.26 Disentanglement. The cutting of a vehicle and/or machinery away from trapped or injured victims.

3.3.27 Dive. An exposure to increased pressure whether underwater or in a hyperbaric chamber.

3.3.28 Dive Operation. A situation requiring divers to complete an assigned task.

3.3.29 Dive Team. An organization of public safety divers and members in training.

3.3.30 Diver. An individual using breathing apparatus that supplies compressed breathing gas at the ambient pressure.

3.3.31 Edge Protection. A means of protecting software components within a rope rescue system from the potentially harmful effects of exposed sharp or abrasive edges.

3.3.32 Emergency Incident. Any situation to which the emergency services organization responds to deliver emergency services, including rescue, fire suppression, emergency medical care, special operations, law enforcement, and other forms of hazard control and mitigation. [**1561:**3.3]

3.3.33 Emergency Medical Service (EMS). The organization(s) responsible for the care and transport of sick and injured persons to an appropriate emergency care facility. Referred to as Emergency Services in U.S. federal confined space regulations.

3.3.34 Engulfment. The surrounding and effective capture of a person by a fluid (e.g., liquid, finely divided particulate) substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

3.3.35 Entry. The action by which a person passes into a confined space. Entry includes ensuing work or rescue activities in that environment and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space, trench, or excavation.

3.3.36* Entry Permit. A written or printed document, established by an employer, for nonrescue entry into confined spaces.

3.3.37 Entry Team. The group of individuals, with established communications and leadership, assigned to perform work or rescue activities beyond the opening of, and within, the space, trench, or excavation.

3.3.38* Environment. A collection of characteristics such as weather, altitude, and terrain contained in an area that are unique to a location.

3.3.39 Excavation. Any man-made cut, cavity, trench, or depression in an earth surface, formed by the removal of earth.

3.3.40 Extrication. The removal of trapped victims from a vehicle or machinery.

3.3.41 Face(s). The vertical or inclined earth surface formed as a result of excavation work.

3.3.42 Failure. The breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

3.3.43* Federal Response Plan. A U.S. government plan for the basic mechanisms and structures by which the federal government will mobilize resources and conduct activities to augment state and local disaster and emergency response efforts.

3.3.44* FEMA Task Force Search and Rescue Marking System. Distinct markings made with international orange spray paint near a collapsed structure's most accessible point of entry.

3.3.45* FEMA Task Force Structure/Hazard Evaluation Marking System. Distinct markings made with international orange spray paint, after performing a building hazard identification, near a collapsed structure's most accessible point of entry.

3.3.46* FEMA Task Force Structure Marking System, Structure Identification within a Geographic Area. Distinct markings made with international orange spray paint to label buildings with their street number so that personnel can differentiate one building from another.

3.3.47 Fixed Line (Fixed Line System). A rope rescue system consisting of a nonmoving rope attached to an anchor system.

3.3.48 Force Multiplier. Any load, object, environmental factor, or system configuration that increases the load on the anchor system(s).

3.3.49 Full Face Mask. A diving mask that covers the diver's entire face, includes a regulator for breathing, has separate inhalation and exhalation chambers, provides for defogging, free flow if the seal is broken, and provides for a communication module.

3.3.50* General Area. An area surrounding the incident site (e.g., collapsed structure or trench) whose size is proportional to the size and nature of the incident. Within the general area, access by people, heavy machinery, and vehicles is limited and strictly controlled.

3.3.51 Grade Pole. A wood or fiberglass pole, either cut to a certain length or provided with markings, used by workers when setting pipes on grade.

3.3.52 Hardware. Rigid mechanical auxiliary equipment that can include, but is not limited to, anchor plates, carabiners, and mechanical ascent and descent control devices.

3.3.53 Harness. See 3.3.69, Life Safety Harness.

3.3.54 Hazard Identification. The process of identifying situations or conditions that have the potential to cause injury to people, damage to property, or damage to the environment.

3.3.55 Hazardous Atmospheres. Any atmosphere that can expose personnel to the risk of death, incapacitation, injury, acute illness, or impairment of ability to self-rescue. [**1006:**3.3]

3.3.56 Heavy Object. An item of such size and weight that it cannot be moved without the use of power tools (e.g., hydraulic lifting devices) or complex mechanical advantage systems.

3.3.57 High Angle. Refers to an environment in which the load is predominantly supported by the rope rescue system.

3.3.58 Hitch. A knot that attaches to or wraps around an object so that when the object is removed, the knot will fall apart.

3.3.59 Immediately Dangerous to Life or Health (IDLH). Any condition that would pose an immediate or delayed threat to life, cause irreversible adverse health effects, or interfere with an individual's ability to escape unaided from a hazardous environment.

3.3.60 Imminent Hazard. An act or condition that is judged to present a danger to persons or property and is so immediate and severe that it requires immediate corrective or preventive action.

3.3.61 Incident Command System (ICS). The combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure that has responsibility for the management of assigned resources to effectively accomplish stated objectives pertaining to an incident or training exercise.

3.3.62 Incident Commander. The person who is responsible for all decisions relating to the management of the incident and is in charge of the incident site. [**472:**3.3]

3.3.63 Incident Management System (IMS). A system that defines the roles and responsibilities to be assumed by personnel and the operating procedures to be used in the management and direction of emergency operations; the system is also referred to as an incident command system (ICS). [**1021:**3.3]

3.3.64 Incident Response Plan. Written procedures, including standard operating guidelines, for managing an emergency response and operation.

3.3.65* Incident Scene. The location where activities related to a specific incident are conducted.

3.3.66* Isolation System (or Isolation Devices). An arrangement of devices, applied with specific techniques, that collectively serve to isolate a victim of a trench or excavation emergency from the surrounding product (e.g., soil, gravel, or sand).

3.3.67* Knot. A fastening made by tying together lengths of rope or webbing in a prescribed way.

3.3.68 Laser Target. A square or rectangular plastic device used in conjunction with a laser instrument to set the line and grade of pipe.

3.3.69 Life Safety Harness. A system component that is an arrangement of materials secured about the body and used to support a person during rescue.

3.3.70 Life Safety Rope. A compact but flexible, torsionally balanced, continuous structure of fibers produced from strands that are twisted, plaited, or braided together and that serve primarily to support a load or transmit a force from the point of origin to the point of application.

3.3.71 Litter. A transfer device designed to support and protect a victim during movement.

3.3.72 Litter Attendant. A person who both accompanies and physically manages the litter.

3.3.73* Load. That which is being lowered or raised by rope in a high-angle system.

3.3.74* Lockout. A method for keeping equipment from being set in motion and endangering workers.

3.3.75 Low Angle. Refers to an environment in which the load is predominantly supported by itself and not the rope rescue system (e.g., flat land or mild sloping surface).

3.3.76* Lowering System. A rope rescue system used to lower a load under control.

3.3.77 Machinery. The moving parts of a particular machine.

3.3.78 Maximum Working Load. Weight supported by the life safety rope and system components that must not be exceeded.

3.3.79* Mechanical Advantage (M/A). A force created through mechanical means including, but not limited to, a system of levers, gearing, or ropes and pulleys usually creating an output force greater than the input force and expressed in terms of a ratio of output force to input force.

3.3.80* National Search and Rescue Plan. A document that identifies responsibilities of U.S. federal agencies and serves as the basis for the National Search and Rescue Manual, which discusses search and rescue organizations, resources, methods, and techniques utilized by the federal government.

3.3.81 One-Call Utility Location Service. A service from which contractors, emergency service personnel, and others can obtain information on the location of underground utilities in any area.

3.3.82 Oxygen-Deficient Atmosphere. Air atmospheres containing less than 19.5 percent oxygen by volume at one standard atmosphere pressure.

3.3.83 Oxygen-Enriched Atmosphere. Air atmospheres containing more than 23.5 percent oxygen by volume at one standard atmosphere pressure.

3.3.84 Packaging (Patient Packaging). The process of securing a subject in a transfer device, with regard to existing and potential injuries/illness, so as to avoid further harm during movement.

3.3.85 Panel. See 3.3.147, Traditional Sheeting and Shoring.

3.3.86 Panel Team. The group of individuals, with established communications and leadership, assigned to construct (if necessary), move, place, and manage panels (traditional sheeting panels) both inside and outside the space, trench, or excavation.

3.3.87* Personal Protective Equipment (PPE). The equipment provided to shield or isolate personnel from infectious, chemical, physical, and thermal hazards.

3.3.88 Personnel. Any individual participating within the incident scene.

3.3.89 Pier Hole. See 3.3.11, Bell-Bottom Pier Hole.

3.3.90 Pre-Entry Briefing. Information passed to all personnel prior to entry into a confined space or trench/excavation environment.

3.3.91 Primary Access. The existing opening of doors and/or windows that provide a pathway to the trapped and/or injured victim(s).

3.3.92* Protective System. A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures.

3.3.93 Public Safety Diver. An individual who performs public safety diving.

3.3.94 Public Safety Diving. Underwater diving, related to team operations and training, performed by any member, group, or agency of a community or government-recognized public safety diving or water rescue team.

3.3.95 Pulley. A device with a free-turning, grooved metal wheel (sheave) used to reduce rope friction. Side plates are available for a carabiner to be attached.

3.3.96* Raising System. A rope rescue system used to raise a load under control.

3.3.97 "Reach, Throw, Row, Go." The four sequential steps in water rescue with progressively more risk to the rescuer. Specifically, a "go" rescue involves physically entering the medium (e.g., in the water or on the ice).

3.3.98 Recovery. Activities and programs designed to return the entity to an acceptable condition.

3.3.99 Redundant Air System. An independent secondary underwater breathing system (i.e., a pony bottle with first and second stage or a pony bottle supplying a bailout block).

3.3.100* Registered Professional Engineer. A person who is registered as a professional engineer in the state where the work is to be performed.

3.3.101 Rescue. Those activities directed at locating endangered persons at an emergency incident, removing those persons from danger, treating the injured, and providing for transport to an appropriate health care facility.

3.3.102* Rescue Area. An area surrounding the incident site (e.g., collapsed structure or trench) whose size is proportional to the hazards that exist.

3.3.103 Rescue Attendant. A person who is qualified to be stationed outside a confined space to monitor rescue entrants, summon assistance, and perform non-entry rescues.

3.3.104 Rescue Entrant. A person entering a confined space for the specific purpose of rescue.

3.3.105 Rescue Incident. An emergency incident that primarily involves the rescue of persons subject to physical danger and that could include the provision of emergency medical care, but not necessarily.

3.3.106 Rescue Team Leader. The person designated within the incident command system as rescue group/division officer responsible for direct supervision of the rescue team operations.

3.3.107 Resource Assessment. The component of the assessment phase that involves the determination for the need for additional resources. Resource assessment can be ongoing throughout the entire incident.

3.3.108 Resources. All personnel and equipment that are available, or potentially available, for assignment to incidents.

3.3.109* Retrieval System. Combinations of rescue equipment used for nonentry (external) rescue of persons from confined spaces.

3.3.110 Risk. A measure of the probability and severity of adverse effects that result from an exposure to a hazard.

3.3.111 Risk Assessment. An assessment of the likelihood, vulnerability, and magnitude of incidents that could result from exposure to hazards.

3.3.112* Risk/Benefit Analysis. A decision made by a responder based on a hazard identification and situation assessment that weighs the risks likely to be taken against the benefits to be gained for taking those risks.

3.3.113 Rope. See 3.3.70, Life Safety Rope.

3.3.114 Rope-Based Mechanical Advantage System. A rope rescue system component incorporating the reeving of rope through moving pulleys (or similar devices) to create mechanical advantage.

3.3.115 Rope Rescue Equipment. Components used to build rope rescue systems including life safety rope, life safety harnesses, and auxiliary equipment.

3.3.116 Rope Rescue System. A system comprised of rope rescue equipment and an appropriate anchor system intended for use in the rescue of a subject.

3.3.117 Safety Officer. An individual appointed by the AHJ as qualified to maintain a safe working environment.

3.3.118 Search Marking System. A separate and distinct marking system used to identify information related to the location of a victim(s).

3.3.119 Secondary Access. Openings created by rescuers that provide a pathway to trapped and/or injured victims.

3.3.120 Sheeting. The members of a shoring system that support the sides of an excavation and are in turn supported by other members of the shoring system.

3.3.121* Shield (or Shield System). A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structures.

3.3.122 Shoring (or Shoring System). A structure such as a metal hydraulic, pneumatic/mechanical, or timber system that supports the sides of an excavation and is designed to prevent cave-ins.

3.3.123 Shoring Team. The group of individuals, with established communications and leadership, assigned to construct, move, place, and manage the shoring or shoring system inside the space, trench, or excavation.

3.3.124 Sides. See 3.3.41, Face(s).

3.3.125 Single-Point Anchor System. An anchor system configuration utilizing a single anchor point to provide the primary support for the rope rescue system. A single-point anchor system includes those anchor systems that utilize one or more additional nonloaded anchor points as backup to the primary anchor point.

3.3.126 Size-Up. A mental process of evaluating the influencing factors at an incident prior to committing resources to a course of action.

3.3.127 Software. A flexible fabric component of rope rescue equipment that can include, but is not limited to, anchor straps, pick-off straps, and rigging slings.

3.3.128 Special Operations. Those emergency incidents to which the responding agency responds that require specific and advanced technical training and specialized tools and equipment.

3.3.129 Standard Operating Guideline. An organizational directive that establishes a course of action or policy.

3.3.130 Standard Operating Procedure. A written organizational directive that establishes or prescribes specific operational or administrative methods to be followed routinely for the performance of designated operations or actions. [**1521:**3.3]

3.3.131* Strongback. The vertical members of a trench shoring system placed in contact with the earth, usually held in place against sections of sheeting with shores and positioned so that individual members do not contact each other.

3.3.132* Supplemental Sheeting and Shoring. Sheeting and shoring operations that involve the use of commercial sheeting/shoring systems and/or isolation devices or that involve cutting and placement of sheeting and shoring when greater than two feet of shoring exists below the bottom of the strongback.

3.3.133 Support System. A structure, such as underpinning, bracing, or shoring, that provides support to an adjacent structure, underground installation, or the sides of an excavation.

3.3.134 Surcharge Load. Any weight near the lip of the trench that increases the likelihood of instability or secondary cave-in.

3.3.135 Swift Water. Water moving at a rate greater than one knot [1.85 km/hr (1.15 mph)].

3.3.136* System Safety Factor. The weakest point within a system, expressed as a ratio between the minimum breaking strength of that point (component) as compared to the force placed upon it.

3.3.137 System Stress. Any condition creating excessive force (i.e., exceeding the maximum working load of any component) to components within a rope rescue system that could lead to damage or failure of the system.

3.3.138* Tabulated Data. Any set of site-specific design data used by a professional engineer to design a protective system at a particular location.

3.3.139 Tagout. A method of tagging, labeling, or otherwise marking an isolation device during hazard abatement operations to prevent accidental removal of the device. *(See also 3.3.74, Lockout.)*

3.3.140 Technical Rescue. The application of special knowledge, skills, and equipment to safely resolve unique and/or complex rescue situations.

3.3.141* Technical Rescue Incident. Complex rescue incidents requiring specially trained personnel and special equipment to complete the mission.

3.3.142 Tender. An individual trained in the responsibilities of diver safety who provides control of search patterns from the surface of the water.

3.3.143 Termination. That portion of incident management in which personnel are involved in documenting safety procedures, site operations, hazards faced, and lessons learned from the incident. Termination is divided into three phases: debriefing the incident, post-incident analysis, and critiquing the incident.

3.3.144* Terrain. Specific natural and topographical features within an environment.

3.3.145* Terrain Hazard. Specific terrain feature, or feature-related condition, that exposes one to danger and the potential for injury and/or death.

3.3.146 Testing. The process by which the hazards that could confront entrants of a trench or excavation are identified and evaluated, including specifying tests that are to be performed in a trench or excavation.

3.3.147* Traditional Sheeting and Shoring. The use of 1.2 m ×2.4 m (4 ft ×8 ft) sheet panels, with a strongback attachment, supplemented by a variety of conventional shoring options such as hydraulic, screw, and/or pneumatic shores.

3.3.148 Transfer Device. Various devices, including litters and harnesses, used with rope rescue systems to package and allow safe removal of a subject from a specific rescue environment.

3.3.149 Trench Box (or Trench Shield). A manufactured protection system unit made from steel, fiberglass, or aluminum that is placed in a trench to protect workers from cave-in and that can be moved as a unit. *[See also 3.3.121, Shield (or Shield System).]*

3.3.150* Trench (or Trench Excavation). A narrow (in relation to its length) excavation made below the surface of the earth.

3.3.151 Vehicle. A device or structure for transporting persons or things; a conveyance.

3.3.152 Watermanship Skills. Capabilities that include swimming, surface diving, treading water, and staying afloat with a reasonable degree of comfort appropriate to the required task.

3.3.153 Webbing. Woven material of flat or tubular weave in the form of a long strip.

3.3.154* Wilderness. An uncultivated, uninhabited, and natural area usually, but not necessarily, far from human civilization and trappings.

3.3.155 Wire Rope. Rope made of twisted strands of wire.

Chapter 4 General Requirements

4.1 General.

4.1.1* The authority having jurisdiction (AHJ) shall establish levels of operational capability needed to conduct operations at technical search and rescue incidents safely and effectively, based on hazard identification, risk assessment, training level of personnel, and availability of internal and external resources.

4.1.2 The AHJ shall establish written standard operating procedures consistent with one of the following operational levels:

(1)* *Awareness level.* This level represents the minimum capability of organizations that provide response to technical search and rescue incidents.

(2)* *Operations level.* This level represents the capability of organizations to respond to technical search and rescue incidents and to identify hazards, use equipment, and apply limited techniques specified in this standard to support and participate in technical search and rescue incidents.

(3) *Technician level.* This level represents the capability of organizations to respond to technical search and rescue incidents, to identify hazards, use equipment, and apply advanced techniques specified in this standard necessary to coordinate, perform, and supervise technical search and rescue incidents.

4.1.3 The AHJ shall establish operational procedures consistent with the identified level of operational capability to ensure that technical search and rescue operations are performed in a manner that minimizes threats to rescuers and others.

4.1.4 The same techniques used in a search and rescue operation shall be considered equally useful for training, body recovery, evidence search, and other operations with a level of urgency commensurate with the risk/benefit analysis.

4.1.5 Operational procedures shall not exceed the identified level of capability established in 4.1.2.

4.1.6* At a minimum, medical care at the basic life support (BLS) level shall be provided by the organization at technical search and rescue incidents.

4.1.7 Training.

4.1.7.1 The AHJ shall provide for training in the responsibilities that are commensurate with the operational capability of the organization.

4.1.7.1.1 The minimum training for an organization shall be at the awareness level.

4.1.7.1.2 Organizations expected to perform at a higher operational level shall be trained to that level.

4.1.7.2* The AHJ shall provide for the continuing education necessary to maintain all requirements of the organization's identified level of capability.

4.1.7.3 An annual performance evaluation of the organization based on requirements of this standard shall be performed.

4.1.7.4* The AHJ shall evaluate its training program to determine whether the current training has prepared the organization to function at the established operational level under abnormal weather conditions, extremely hazardous operational conditions, and other difficult situations.

4.1.7.5* Documentation.

4.1.7.5.1 The AHJ shall be responsible for the documentation of all required training.

4.1.7.5.2 This documentation shall be maintained and available for inspection by individual team members and their authorized representatives.

4.1.8 Prior to operating at a technical search and rescue incident, an organization shall meet the requirements specified in Chapter 4 as well as all relevant requirements of Chapters 5 through 11 for the specific technical rescue incident.

4.1.9 Standard Operating Procedure.

4.1.9.1 The AHJ shall ensure that there is a standard operating procedure to evacuate members from an area and to account for their safety when an imminent hazard condition is discovered.

4.1.9.2 This procedure shall include a method to notify all members in the affected area immediately by any effective means including audible warning devices, visual signals, and radio signals.

4.1.10* The AHJ shall comply with all applicable local, state, and federal laws.

4.1.11* The AHJ shall train responsible personnel in procedures for invoking relevant components of the National Search and Rescue Plan, the Federal Response Plan, and other state and local response plans.

4.2 Hazard Identification and Risk Assessment.

4.2.1* The AHJ shall conduct a hazard identification and risk assessment of the response area and shall determine the feasibility of conducting technical search and rescue operations.

4.2.2 The hazard identification and risk assessment shall include an evaluation of the environmental, physical, social, and cultural factors influencing the scope, frequency, and magnitude of a potential technical search and rescue incident and the impact they might have on the ability of the AHJ to respond to and to operate while minimizing threats to rescuers at those incidents.

4.2.3* The AHJ shall identify the type and availability of internal resources needed for technical search and rescue incidents and shall maintain a list of those resources.

4.2.4* The AHJ shall identify the type and availability of external resources needed to augment existing capabilities for technical search and rescue incidents and shall maintain a list of these resources. This list shall be updated at least once a year.

4.2.5* The AHJ shall establish procedures for the acquisition of those external resources needed for technical search and rescue incidents.

4.2.6 The hazard identification and risk assessment shall be documented.

4.2.7 The hazard identification and risk assessment shall be reviewed and updated on a scheduled basis and as operational or organizational changes occur.

4.2.8 At intervals determined by the AHJ, the AHJ shall conduct surveys in the organization's response area for the purpose of identifying the types of technical search and rescue incidents that are most likely to occur.

4.3 Incident Response Planning.

4.3.1 The procedures for a technical search and rescue emergency response shall be documented in the special operations incident response plan.

4.3.1.1 The plan shall be a formal, written document.

4.3.1.2 Where external resources are required to achieve a desired level of operational capability, mutual aid agreements shall be developed with other organizations.

4.3.2 Copies of the technical search and rescue incident response plan shall be distributed to agencies, departments, and employees having responsibilities designated in the plan.

4.3.3 A record shall be kept of all holders of the technical search and rescue incident response plan, and a system shall be implemented for issuing all changes or revisions.

4.3.4 The technical search and rescue incident response plan shall be approved by the AHJ through a formal, documented approval process and shall be coordinated with participating agencies and organizations.

4.4 Equipment.

4.4.1 Operational Equipment.

4.4.1.1* The AHJ shall ensure that equipment commensurate with the respective operational capabilities for operations at technical search and rescue incidents and training exercises is provided.

4.4.1.2 Training shall be provided to ensure that all equipment is used and maintained in accordance with the manufacturers' instructions.

4.4.1.3 Procedures for the inventory and accountability of all equipment shall be developed and used.

4.4.2 Personal Protective Equipment (PPE).

4.4.2.1* The AHJ shall ensure that the protective clothing and equipment is supplied to provide protection from those hazards to which personnel are exposed or could be exposed.

4.4.2.2 Personnel shall be trained in the care, use, inspection, maintenance, and limitations of the protective clothing and equipment assigned or available for their use.

4.4.2.3 The AHJ shall ensure that all personnel wear and use personal protective equipment while working in known or suspected hazardous areas during technical search and rescue incidents and training exercises.

4.4.2.4 The AHJ shall ensure that atmospheric supplying respirators in the form of supplied air respirators (SAR) or self-contained breathing apparatus (SCBA) are available when required for technical search and rescue operations and that they meet the requirements specified in Chapter 7 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*.

4.4.2.4.1 Breathing apparatus shall be worn in accordance with the manufacturer's recommendations.

4.4.2.4.2 A supply source of breathing air meeting the requirements of ANSI/CGA G7.1, *Commodity Specification for Air*, with a minimum air quality of Grade D shall be provided for all atmosphere-supplying respirators.

4.4.2.4.3 A supply source of breathing air meeting the requirements of ANSI/CGA G7.1, *Commodity Specification for Air*, with a minimum air quality of Grade E shall be provided for all atmosphere-supplying respirators used for dive operations.

4.4.2.4.4 Supplied air respirators shall be used in conjunction with a self-contained breathing air supply capable of providing enough air for egress in the event of a primary air supply failure.

4.5 Safety.

4.5.1 General.

4.5.1.1 All personnel shall receive training related to the hazards and risks associated with technical search and rescue operations.

4.5.1.2 All personnel shall receive training for conducting search and rescue operations while minimizing threats to rescuers and using PPE.

4.5.1.3 The AHJ shall ensure that members assigned duties and functions at technical search and rescue incidents and training exercises meet the relevant requirements of the following chapters and sections of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*:

(1) Section 5.4, Special Operations
(2) Chapter 7, Protective Clothing and Protective Equipment
(3) Chapter 8, Emergency Operations

4.5.1.4* Where members are operating in positions or performing functions at an incident or training exercise that pose a high potential risk for injury, members qualified in basic life support shall be standing by.

4.5.1.5* Rescuers shall not be armed except when it is required to meet the objectives of the incident as determined by the AHJ.

4.5.2 Safety Officer.

4.5.2.1 At technical search and rescue training exercises and in actual operations, the incident commander shall assign a safety officer with the specific knowledge and responsibility for the identification, evaluation, and, where possible, correction of hazardous conditions and unsafe practices.

4.5.2.2 The assigned safety officer shall meet the requirements specified in Chapter 6, Functions of the Incident Safety Officer, of NFPA 1521, *Standard for Fire Department Safety Officer*.

4.5.3 Incident Management System.

4.5.3.1* The AHJ shall provide for and utilize training on the implementation of an incident management system that meets the requirements of NFPA 1561, *Standard on Emergency Services Incident Management System*, with written standard operating procedures applying to all members involved in emergency operations. All members involved in emergency operations shall be familiar with the system.

4.5.3.2 The AHJ shall provide for training on the implementation of an incident accountability system that meets the requirements of NFPA 1561, *Standard on Emergency Services Incident Management System*.

4.5.3.3 The incident commander shall ensure rotation of personnel to reduce stress and fatigue.

4.5.3.4 The incident commander shall ensure that all personnel are aware of the potential impact of their operations on the safety and welfare of rescuers and others, as well as on other activities at the incident site.

4.5.3.5 At all technical search and rescue incidents, the organization shall provide supervisors who possess skills and knowledge commensurate with the operational level identified in 4.1.2.

4.5.4* Fitness. The AHJ shall ensure that members are psychologically, physically, and medically capable to perform assigned duties and functions at technical search and rescue incidents and to perform training exercises in

accordance with Chapter 10 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*.

4.5.5 Nuclear, Biological, and Chemical Response.

4.5.5.1* The authority having jurisdiction, as part of its hazard identification and risk assessment, shall determine the potential to respond to technical search and rescue incidents that might involve nuclear or biological weapons, chemical agents, or weapons of mass destruction, including those with the potential for secondary devices.

4.5.5.2 If the AHJ determines that a valid risk exists for technical search and rescue response into a nuclear, biological, and/or chemical environment, it shall provide training and equipment for response personnel.

Chapter 5 Structural Collapse

5.1 General Requirements.

Organizations operating at structural collapse incidents shall meet the requirements specified in Chapter 4.

5.2 Awareness Level.

5.2.1 Organizations operating at the awareness level for structural collapse incidents shall meet the requirements specified in Sections 5.2 and 7.2 (awareness level for confined space search and rescue).

5.2.2 Organizations operating at the awareness level for structural collapse incidents shall implement procedures for the following:

(1) Recognizing the need for structural collapse search and rescue

(2)* Identifying the resources necessary to conduct structural collapse search and rescue operations

(3)* Initiating the emergency response system for structural collapse incidents

(4)* Initiating site control and scene management

(5)* Recognizing the general hazards associated with structural collapse incidents, including the recognition of applicable construction types and categories and the expected behaviors of components and materials in a structural collapse

(6)* Identifying the five types of collapse patterns and potential victim locations

(7)* Recognizing the potential for secondary collapse

(8)* Conducting visual and verbal searches at structural collapse incidents, while using approved methods for the specific type of collapse

(9)* Recognizing and implementing the FEMA Task Force Search and Rescue Marking System, Building Marking System (structure/hazard evaluation), Victim Location Marking System, and Structure Marking System (structure identification within a geographic area)

(10) Removing readily accessible victims from structural collapse incidents

5.3 Operations Level.

5.3.1 Organizations operating at the operations level for structural collapse incidents shall meet the requirements specified in Sections 5.2 and 5.3 as well as those in the following sections:

(1) Section 6.3 (operations level for rope rescue)

(2) Section 7.3 (operations level for confined space search and rescue)

(3) Section 8.3 (operations level for vehicle and machinery search and rescue)

(4) Section 9.2 (awareness level for water search and rescue)

(5) Section 11.3 (operations level for trench and excavation search and rescue)

5.3.2 The organization shall have members capable of recognizing hazards, using equipment, and implementing techniques necessary to operate at structural collapse incidents involving the collapse or failure of ordinary construction (light frame, unreinforced masonry, and reinforced masonry construction).

5.3.3 Organizations operating at the operations level for structural collapse incidents involving light frame ordinary construction and reinforced and unreinforced masonry construction shall develop and implement procedures for the following:

(1)* Sizing up existing and potential conditions at structural collapse incidents

(2) Recognizing unique collapse or failure hazards

(3)* Conducting search operations intended to locate victims trapped inside and beneath collapse debris

(4)* Accessing victims trapped inside and beneath collapse debris

(5)* Performing extrication operations involving packaging, treating, and removing victims trapped within and beneath collapse debris

(6) Stabilizing the structure

5.4 Technician Level.

5.4.1 Organizations operating at the technician level for structural collapse incidents shall meet the requirements specified in this chapter and the following sections:

(1) Section 6.4 (technician level for rope rescue)

(2) Section 7.4 (technician level for confined space search and rescue)
(3) Section 8.4 (technician level for vehicle and machinery search and rescue)
(4) Section 11.4 (technician level for trench and excavation search and rescue)

5.4.2 The organization shall have members capable of recognizing hazards, using equipment, and implementing techniques necessary to operate at structural collapse incidents involving all types of construction.

5.4.3 Organizations operating at the technician level for structural collapse incidents for all types of construction shall develop and implement procedures for the following:

(1) Evaluating existing and potential conditions at structural collapse incidents
(2) Recognizing unique collapse or failure hazards
(3)* Conducting search operations intended to locate victims trapped inside and beneath collapse debris
(4)* Accessing victims trapped inside and beneath collapse debris
(5)* Performing extrication operations involving packaging, treating, and removing victims trapped within and beneath collapse debris
(6) Stabilizing the structure

Chapter 6 Rope Rescue

6.1 General Requirements.

6.1.1 Organizations operating at rope rescue incidents shall meet the requirements specified in Chapter 4.

6.1.2* The AHJ shall evaluate the need for missing person search where rope rescues might occur within its response area and shall provide a search capability commensurate with the identified needs.

6.2 Awareness Level.

6.2.1 Organizations operating at the awareness level for rope rescue incidents shall meet the requirements specified in Section 6.2.

6.2.2 Organizations operating at the awareness level for rope rescue incidents shall develop and implement procedures for the following:

(1) Recognizing the need for a rope rescue

(2)* Identifying resources necessary to conduct rope rescue operations

(3)* Carrying out the emergency response system where rope rescue is required

(4)* Carrying out site control and scene management

(5)* Recognizing general hazards associated with rope rescue and the procedures necessary to mitigate these hazards

(6)* Identifying and utilizing personal protective equipment assigned for use at a rope rescue incident

6.3 Operations Level.

6.3.1 Organizations operating at the low-angle operations level for rope rescue incidents shall meet the requirements specified in Section 6.2 and 6.3.4 (low-angle operations).

6.3.2 Organizations operating at the high-angle operations level for rope rescue incidents shall meet the requirements specified in Section 6.2, 6.3.4 (low-angle operations), and 6.3.5 (high-angle operations).

6.3.3 The AHJ shall choose to operate at either the low-angle operations level or the high-angle operations level commensurate with the needs of the organization.

6.3.4 Organizations operating at the low-angle operations level for rope rescue incidents shall develop and implement procedures commensurate with the identified needs of the organization for the following in the low-angle environment:

(1)* Sizing up existing and potential conditions at incidents where rope rescue operations will be performed

(2)* Assuring safety in rope rescue operations

(3) Establishing the need for, selecting, and placing edge protection

(4) Selecting, using, and maintaining rope rescue equipment and rope rescue systems

(5)* Configuring all knots, bends, or hitches used by the organization

(6) Selecting anchor points and equipment to construct anchor systems

(7)* Constructing and using single-point anchor systems commensurate with the organization's needs

(8)* Constructing and using multiple-point, load-sharing anchor systems commensurate with the organization's needs

(9) Selecting, constructing, and using a belay system commensurate with the organization's needs

(10) Selecting and using methods necessary to negotiate an edge or other obstacle that includes protecting all personnel working nearby from accidental fall

(11) Ascending and descending a fixed rope

(12) Selecting and using methods necessary for personnel to escape from jammed or otherwise dysfunctional descent and ascent devices when descending and ascending a fixed rope

(13)* Selecting, constructing, and using a lowering system commensurate with the organization's needs

(14) Securing a patient in a litter

(15) Attaching a litter to a rope rescue system commensurate with the organization's needs

(16) Utilizing litter attendants commensurate with the organization's needs

(17) Selecting, constructing, and using rope-based mechanical advantage systems commensurate with the organization's needs

(18)* Selecting, constructing, and using raising systems commensurate with the organization's needs

6.3.5 Organizations operating at the high-angle operations level shall develop and implement procedures commensurate with the identified needs of the organization for the following in the high-angle environment:

(1)* Sizing up existing and potential conditions at incidents where rope rescue operations will be performed

(2)* Assuring safety in rope rescue operations

(3) Establishing the need for, selecting, and placing edge protection

(4) Selecting, using, and maintaining rope rescue equipment and rope rescue systems

(5)* Configuring all knots, bends, or hitches used by the organization

(6) Selecting anchor points and equipment to construct anchor systems

(7)* Constructing and using single-point anchor systems commensurate with the organization's needs

(8)* Constructing and using multiple-point, load-sharing anchor systems commensurate with the organization's needs

(9) Selecting, constructing, and using a belay system commensurate with the organization's needs

(10) Selecting and using methods necessary to negotiate an edge or other obstacle that includes protecting all personnel working nearby from accidental fall

(11) Ascending and descending a fixed rope

(12) Selecting and using methods necessary for personnel to escape from jammed or otherwise dysfunctional ascent and descent control devices when ascending and descending a fixed rope

(13)* Selecting, constructing, and using a lowering system commensurate with the organization's needs

(14) Securing a patient in a litter

(15) Attaching a litter to a rope rescue system commensurate with the organization's needs

(16) Utilizing litter attendants commensurate with the organization's needs

(17) Selecting, constructing, and using rope-based mechanical advantage systems commensurate with the organization's needs

(18)* Selecting, constructing, and using raising systems commensurate with the organization's needs

6.4 Technician Level.

6.4.1 Organizations operating at the technician level for rope rescue incidents shall meet all the requirements specified in this chapter.

6.4.2 Organizations operating at the technician level for rope rescue incidents shall develop and implement procedures for the following:

(1) Evaluating existing and potential conditions at incidents where rope rescue operations will be performed

(2) Understanding of the basic physics involved in constructing rope rescue systems, including system safety factors, critical angles, and the causes and effects of force multipliers within rope rescue systems

(3) Negotiating obstacles while ascending and descending a fixed rope commensurate with the organization's needs

(4) Constructing and using multiple-point, load-distributing anchor systems commensurate with the organization's needs

(5) Passing knots through a rope rescue raising or lowering system commensurate with the organization's needs

(6) Constructing an elevated point to facilitate safe transition of rescuers or victims over difficult edges

(7) Selecting, constructing, and using a high-line rope system commensurate with the organization's needs

(8) Utilizing a high-line rope system to transport rescuers, equipment, and an occupied litter commensurate with the organization's needs

(9) Utilizing litter attendants within a high-line rope system

Chapter 7 Confined Space Search and Rescue

7.1 General Requirements.

7.1.1 Organizations operating at confined space incidents shall meet the requirements specified in Chapter 4.

7.1.2* The requirements of this chapter shall apply to organizations that provide varying degrees of response to confined space emergencies.

7.1.3 All confined space rescue services shall meet the requirements defined in 7.1.3.1 through 7.1.3.12.

7.1.3.1 Each member of the rescue service shall be provided with, and trained to use properly, the personal protective equipment and rescue equipment necessary for making rescues from confined spaces according to his or her designated level of competency.

7.1.3.2 Each member of the rescue service shall be trained to perform the assigned rescue duties corresponding to his or her designated level of competency.

7.1.3.3 Each member of the rescue service shall also receive the training required of authorized rescue entrants.

7.1.3.4 Each member of the rescue service shall practice making confined space rescues, in accordance with the requirements of 4.1.7 of this document, by means of simulated rescue operations in which he or she removes dummies, mannequins, or persons from actual confined spaces or from representative confined spaces.

7.1.3.5 Representative confined spaces should — with respect to opening size, configuration, and accessibility — simulate the types of confined spaces from which rescue is to be performed.

7.1.3.6 Each member of the rescue service shall be certified to the level of first responder or equivalent according to U.S. Department of Transportation (DOT) *First Responder Guidelines.*

7.1.3.7 Each member of the rescue service shall successfully complete a course in cardiopulmonary resuscitation (CPR) taught through the American Heart Association (AHA) to the level of a "Health Care Provider," through the American Red Cross (ARC) to the "CPR for the Professional Rescuer" level, or through the National Safety Council's equivalent course of study.

7.1.3.8* The rescue service shall be capable of responding in a timely manner to rescue summons.

7.1.3.9 Each member of the rescue service shall be equipped, trained, and capable of functioning to perform confined space rescues within the area for which they are responsible at their designated level of competency.

7.1.3.10 The requirements of 7.1.3.9 shall be confirmed by an annual evaluation of the rescue service's capabilities to perform confined space rescues in terms of overall timeliness, training, and equipment and to perform safe and effective rescue in those types of spaces to which the team must respond.

7.1.3.11 Each member of the rescue service shall be aware of the hazards he or she could confront when called on to perform rescue within confined spaces for which the service is responsible.

7.1.3.12 If required to provide confined space rescue within U.S. federally regulated industrial facilities, the rescue service shall have access to all confined spaces from which rescue could be necessary so that they can develop rescue plans and practice rescue operations according to their designated level of competency.

7.1.4 A confined space rescue team shall be made up of a minimum of six individuals for organizations operating at the technician level, and a minimum of four individuals for organizations operating at the operations level.

7.2 Awareness Level.

7.2.1 Organizations operating at the awareness level for confined space search and rescue incidents shall meet the requirements specified in Sections 7.2 and 6.2 (awareness level for rope rescue).

7.2.2 All members of the organization shall meet the requirements of Chapter 4 of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*.

7.2.3 Organizations at the awareness level shall be responsible for performing certain nonentry rescue (retrieval) operations.

7.2.4 Organizations operating at the awareness level for confined space search and rescue incidents shall implement procedures for the following:

(1) Recognizing the need for confined space search and rescue

(2) Initiating contact and establishing communications with victims where possible

(3)* Recognizing and identifying the hazards associated with nonentry confined space emergencies

(4)* Recognizing confined spaces

(5)* Performing a nonentry retrieval
(6)* Implementing the emergency response system for confined space emergencies
(7)* Implementing site control and scene management

7.3 Operations Level.

7.3.1 Organizations operating at the operations level for confined space search and rescue incidents shall meet the requirements specified in Sections 7.2 and 7.3, as well as in the following sections:

(1) Section 6.3 (operations level for rope rescue)
(2) Section 11.2 (awareness level for trench and excavation search and rescue)

7.3.2 The organization operating at this level shall be responsible for the development and training of a confined space rescue team of at least four individuals who are trained, equipped, and available to respond to confined space emergencies of a type and complexity that requires an operations level organization.

7.3.3 Organizations operating at the operations level shall develop and implement procedures for the following:

(1)* Sizing up existing and potential conditions at confined space emergencies
(2)* Protecting personnel from hazards within the confined space
(3)* Ensuring that personnel are capable of managing the physical and psychological challenges that affect rescuers entering confined spaces
(4)* Identifying the duties of the rescue entrant(s) and backup rescue entrant(s), rescue attendant, and rescue team leader as defined herein
(5)* Monitoring continuously, or at frequent intervals, the atmosphere in all parts of the space to be entered for oxygen content, flammability (LEL/LFL), and toxicity, in that order
(6)* Performing entry-type rescues into confined spaces meeting all of the following specific qualifying characteristics:
  (a)* The internal configuration of the space is clear and unobstructed so retrieval systems can be utilized for rescuers without possibility of entanglement.
  (b)* The victim can be easily seen from the outside of the space's primary access opening.
  (c)* Rescuers can pass easily through the access/egress opening(s) with room to spare when PPE is worn in the manner recommended by the manufacturer.
  (d)* The space can accommodate two or more rescuers in addition to the victim.
  (e)* All hazards in and around the confined space have been identified, isolated, and controlled.
(7)* Using victim packaging devices that could be employed in confined space rescue
(8) Transferring victim information including location, surroundings, condition when found, present condition, and other pertinent information to emergency medical services personnel
(9)* Planning and implementing a confined space rescue operation
(10)* Selecting, constructing, and using a rope lowering and raising system in the high-angle environment

7.4 Technician Level.

7.4.1 Organizations operating at the technician level for confined space search and rescue emergencies shall meet the requirements of this chapter and Section 8.4 (technician level for vehicle and machinery search and rescue).

7.4.2* The organization operating at this level shall be responsible for the development of a confined space rescue team of at least six individuals who are trained, equipped, and available to respond to confined space emergencies of a type and complexity that requires a technician level organization.

7.4.3 Organizations operating at the technician level for confined space search and rescue emergencies shall develop and implement procedures for the following:

(1)* Evaluating existing and potential conditions at confined space emergencies
(2)* Ensuring that rescue team members take part in a medical surveillance program
(3)* Planning response for entry-type confined space rescues in hazardous environments
(4)* Implementing the planned response

Chapter 8 Vehicle and Machinery Search and Rescue

8.1* General Requirements.

Organizations operating at vehicle and machinery search and rescue incidents shall meet the requirements specified in Chapter 4.

8.2 Awareness Level.

8.2.1 Organizations operating at the awareness level for vehicle and machinery emergencies shall meet the requirements specified in Section 8.2.

8.2.2 All members of the organization shall meet the requirements specified in Chapter 4 of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*.

8.2.3 Organizations operating at the awareness level for vehicle and machinery emergencies shall implement procedures for the following:

(1) Recognizing the need for a vehicle and machinery search and rescue
(2)* Identifying the resources necessary to conduct operations
(3)* Initiating the emergency response system for vehicle and machinery search and rescue incidents
(4)* Initiating site control and scene management
(5)* Recognizing general hazards associated with vehicle and machinery search and rescue incidents
(6) Initiating traffic control

8.3 Operations Level.

8.3.1 Organizations operating at the operations level for vehicle and machinery emergencies shall meet the requirements specified in Sections 8.2 and 8.3.

8.3.2 All members of the organization shall meet the requirements of Chapter 5 of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*.

8.3.3 The organization shall have members capable of recognizing hazards, using equipment, and implementing techniques necessary to operate safely and effectively at incidents involving persons injured or entrapped in a vehicle or machinery.

8.3.4 Organizations operating at the operations level for vehicle and machinery emergencies shall develop and implement procedures for the following:

(1)* Sizing up existing and potential conditions at vehicle and machinery search and rescue incidents
(2) Identifying probable victim locations and survivability
(3)* Making the search and rescue area safe, including the stabilization and isolation (e.g., lockout/tagout) of all vehicles or machinery involved
(4) Identifying, containing, and stopping fuel release
(5) Protecting a victim during extrication or disentanglement
(6) The packaging of a victim prior to extrication or disentanglement
(7) Accessing victims trapped in a vehicle or machinery
(8)* Performing extrication and disentanglement operations involving packaging, treating, and removing victims trapped in vehicles or machinery through the use of hand and power tools
(9)* Mitigating and managing general and specific hazards (i.e., fires and explosions) associated with vehicle and machinery search and rescue incidents
(10) Procuring and utilizing the resources necessary to conduct vehicle and machinery search and rescue operations
(11) Maintaining control of traffic at the scene of vehicle and machinery search and rescue incidents

8.4 Technician Level.

8.4.1 Organizations operating at the technician level for vehicle and machinery emergencies shall meet the requirements specified in this chapter.

8.4.2 Organizations operating at the technician level for vehicle and machinery emergencies shall develop and implement procedures for the following:

(1) Evaluating existing and potential conditions at vehicle and machinery search and rescue incidents

(2)* Performing extrication and disentanglement operations involving packaging, treating, and removing victims injured or trapped in large, heavy vehicles or machinery

(3)* The advanced stabilization of unusual vehicle and machinery search and rescue situations

(4)* Using all specialized search and rescue equipment immediately available and in use by the organization

Chapter 9 Water Search and Rescue

9.1 General Requirements.

Organizations operating at water incidents shall meet the requirements specified in Chapter 4.

9.2 Awareness Level.

9.2.1 Organizations operating at the awareness level at water search and rescue incidents shall meet the requirements specified in Section 9.2.

9.2.2 Each member of an organization operating at the awareness level shall be a competent person as defined in 3.3.18.

9.2.3 Organizations operating at the awareness level at water search and rescue incidents shall implement procedures for the following:

(1) Recognizing the need for water search and rescue
(2)* Implementing the assessment phase
(3)* Identifying the resources necessary to conduct safe and effective water operations
(4)* Implementing the emergency response system for water incidents
(5)* Implementing site control and scene management
(6)* Recognizing general hazards associated with water incidents and the procedures necessary to mitigate these hazards within the general search and rescue area
(7) Determining rescue versus body recovery

9.3 Operations Level.

9.3.1 Organizations operating at the operations level at water search and rescue incidents shall meet the requirements specified in Section 9.2 and in 9.3.1 through 9.3.5.

9.3.2 For the purposes of this standard, there shall be four separate water-related disciplines for the operations level: dive, ice, surf, and swift water.

9.3.3* Organizations operating at the operations level of one or more specific disciplines shall meet the requirements defined in 9.3.6, 9.3.7, 9.3.8, or 9.3.9 for that discipline.

9.3.4* For personnel operating in the hazard zone, the minimum PPE provided shall include the following:

(1) Personal flotation device (PFD)
(2) Thermal protection
(3)* Helmet appropriate for water rescue
(4) Cutting device
(5) Whistle
(6) Contamination protection (as needed)

9.3.5 Organizations operating at the operations level at water search and rescue incidents shall develop and implement procedures for the following:

(1)* Sizing up existing and potential conditions at incidents where water search and rescue will be performed
(2)* Ensuring personal safety at water operations
(3)* Assessing water conditions in terms of hazards to the victim and rescuer
(4) Separating, isolating, securing, and interviewing witnesses
(5)* Determining the method of victim entrapment
(6)* Evaluating the progress of the planned response to ensure the objectives are being met safely, effectively, and efficiently
(7)* Conducting shore-based rescue operations
(8)* Using throw bags
(9)* Supplying assistance with rigging and mechanical advantage systems to technician-level personnel
(10) Deploying, operating, and recovering any watercraft used by the organization
(11)* Survival swimming and self-rescue
(12)* Identifying and managing heat and cold stress to the rescuer while utilizing PPE
(13) Using victim packaging devices that could be employed by the organization for water rescue

(14)* Transferring victim information including location, surroundings, condition when found, present condition, and other pertinent information to emergency medical services personnel
(15)* Boat-assisted and boat-based operations if boats are used by the organization
(16) Planning to meet operational objectives
(17)* Rapid extrication of accessible victims
(18) Surface water-based search operations

9.3.6 Dive. Organizations operating at the operations level at dive incidents shall develop and implement procedures for the following:
(1)* Recognizing the unique hazards associated with dive operations
(2)* Serving as surface support personnel
(3) Identifying water characteristics
(4)* Operating surface support equipment used in water operations
(5) Procuring the necessary equipment to perform dive operations
(6) Safe entry and recovery of divers from the water
(7)* Participating in safe dive operations in any climate the organization can encounter

9.3.7 Ice. Organizations operating at the operations level at ice rescue incidents shall develop and implement procedures for the following:
(1)* Recognizing the unique hazards associated with ice rescue operations
(2)* Identifying water and ice characteristics
(3)* Operating surface support equipment used in water or ice rescue operations
(4) Procuring the necessary equipment to perform ice rescue operations
(5)* Recognizing and dealing with a victim's hypothermia
(6) Safe entry of divers into the water through an ice hole, if ice diving is performed by the organization

9.3.8 Surf. Organizations operating at the operations level at surf search and rescue incidents shall develop and implement procedures for the following:
(1)* Recognizing the unique hazards associated with surf rescue operations
(2) Operating surface support equipment used in surf rescue operations
(3) Procuring the necessary equipment to perform surf rescue operations
(4)* Self-rescue and survival swimming in surf

9.3.9 Swift Water.

9.3.9.1 Organizations operating at the operations level at swift water search and rescue incidents shall meet the requirements specified in Section 6.3 (operations level for rope rescue).

9.3.9.2 Organizations operating at the operations level at swift water search and rescue incidents shall develop and implement procedures for the following:
(1)* Assessing moving water conditions, characteristics, and features in terms of hazards to the victim and rescuer
(2) Determining the method of victim entrapment
(3)* Using tag lines and tension diagonals (zip lines)
(4)* Self-rescue and survival swimming in swift water

9.4 Technician Level.

9.4.1 Organizations operating at the technician level at water search and rescue incidents shall meet the requirements specified in 9.3.1 through 9.3.5 and 9.4.1 through 9.4.6.

9.4.2 All members of the organization shall meet the requirements specified in Chapter 4 of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*.

9.4.3 For the purposes of this standard, there shall be four separate water-related disciplines for the technician level: dive, ice, surf, and swift water.

9.4.3.1 Organizations operating at the technician level at dive search and rescue incidents shall meet the requirements specified in 9.3.6 and 9.4.6.
9.4.3.2 Organizations operating at the technician level at ice search and rescue incidents shall meet the requirements specified in 9.3.7 and 9.4.7.
9.4.3.3 Organizations operating at the technician level at surf search and rescue incidents shall meet the requirements specified in 9.3.8 and 9.4.8.
9.4.3.4 Organizations operating at the technician level at swift water search and rescue incidents shall meet the requirements specified in 9.3.9 and 9.4.9.
9.4.4 Personnel operating within an organization at the technician level shall possess a level of watermanship skill and comfort applicable to the required task.
9.4.5 Organizations operating at the technician level at water search and rescue incidents shall develop and implement procedures for the following:
(1) Evaluating existing and potential conditions at incidents where water search and rescue will be performed
(2) Planning a response within the capabilities of available resources
(3) Implementing a planned response consistent with the organization's capabilities
(4)* Conducting both boat-assisted and boat-based rescues
(5)* Conducting a “go” rescue
9.4.6 Dive.
9.4.6.1* Certification.
9.4.6.1.1* For all diving members of a technician level organization, the AHJ shall ensure provision of certification by a nationally recognized agency.
9.4.6.1.2 The curriculum for such certification shall be oriented toward the needs and operational requirements of public safety diving as defined herein.
9.4.6.2* For all diving members of a technician level organization, an annual fitness test, Watermanship/Skills Test, and Basic Scuba Skills Evaluation supplied by International Association of Dive Rescue Specialists (IADRS) shall be conducted to maintain public safety diver capability.
9.4.6.3 Organizations operating at the technician level at dive incidents shall develop and implement procedures for the following:
(1)* Skin and SCUBA diving, including the use of any associated equipment
(2) Applying an understanding of physics and physiology as it relates to the underwater environment
(3)* Using dive tables
(4) Dealing with the various underwater environments with which the rescue diver could come into contact
(5) Avoiding and dealing with underwater plants and animals
(6) Conducting and supervising dive operations
(7) Using accepted search techniques
(8)* Identification and management of dive-related maladies including psychological and physiological stress, air embolism, and decompression sickness
(9) Recognizing and managing the impact of near-drowning in cold water
(10)* Utilizing electronic communications within full-face mask equipment during operations
(11)* Utilizing redundant and alternate air sources during low- or out-of-air emergencies
(12)* Utilizing full-body encapsulation equipment, including dry suits, dry hoods, and dry gloves with full-face mask in contaminated water
(13)* Rescuing an entangled diver
(14)* Medical monitoring of divers
(15)* Recovering evidence including locating, securing, and packaging evidence, documenting and maintaining the chain of custody, and documenting the scene
9.4.7 Ice. Organizations operating at the technician level at ice rescue incidents shall develop and implement procedures for the following:
(1)* Self-rescue unique to ice rescue

(2) The reach, throw, row, and go rescue technique unique to ice rescue
(3) The use of watercraft, specialty craft, and specialty equipment unique to ice rescue

9.4.8 Surf. Organizations operating at the technician level at surf rescue incidents shall develop and implement procedures for the following:

(1) The reach, throw, row, and go rescue technique unique to surf rescue
(2) Using watercraft, specialty craft, and specialty equipment unique to surf rescue

9.4.9 Swift Water.

9.4.9.1 Organizations operating at the technician level at swift water rescue incidents shall meet the requirements specified in Section 6.4 (technician level for rope rescue).

9.4.9.2 Organizations operating at the technician level at swift water rescue incidents shall develop and implement procedures for applying rope rescue techniques in the swift water environment.

Chapter 10 Wilderness Search and Rescue

10.1 General Requirements.

Organizations operating at wilderness search and rescue incidents shall meet the requirements specified in Chapter 4.

10.2 Awareness Level.

10.2.1 Organizations operating at the awareness level at wilderness search and rescue incidents shall meet the requirements specified in Section 10.2.

10.2.2 Members of organizations at the awareness level shall be permitted to assist in support functions on a wilderness search and rescue operation but shall not be deployed into the wilderness.

10.2.3 Organizations operating at the awareness level at any wilderness incident shall implement procedures for the following:

(1) Recognizing the need for a wilderness search and rescue

(2)* Initiating the emergency response system for wilderness search and rescue

(3)* Initiating site control and scene management

(4)* Recognizing the general hazards associated with wilderness search and rescue incidents

(5) Recognizing the type of terrain involved in wilderness search and rescue incidents

(6)* Recognizing the limitations of conventional emergency response skills and equipment in various wilderness environments

(7)* Initiating the collection and recording of information necessary to assist operational personnel in a wilderness search and rescue

(8)* Identifying and isolating any reporting parties and witnesses

10.3 Operations Level.

10.3.1 Organizations operating at the operations level at wilderness search and rescue incidents shall meet the requirements specified in Sections 10.2 and 10.3, as well as those in Section 6.3 (operations level for rope rescue).

10.3.2 Organizations operating at the operations level in wilderness search and rescue shall be under the supervision of organizations at the technician level when operating in a wilderness environment.

10.3.2.1* The AHJ shall establish standard operating procedures that identify the specific environments in which operations-level organizations shall be permitted to operate.

10.3.2.2 Outside of the specific environments identified by the AHJ, personnel from technician-level organizations or special resources shall be utilized when operating in a wilderness environment.

10.3.3 Organizations operating at the operations level at wilderness search and rescue incidents shall develop and implement procedures for the following:

(1)* Sizing up existing and potential conditions at incidents where wilderness search and rescue will be performed

(2)* Requesting and interfacing with wilderness search and rescue resources

(3) Providing the specialized medical care and protocols that are unique to the wilderness environment

(4)* Personal survival, body management, and preparedness for the specific wilderness environments in which the rescuer could become involved

(5) Recognizing the need for, and procedures and equipment for the provision of, environmental protection through clothing systems applicable to the specific wilderness environments in which the rescuer could become involved

(6)* Selection, care, and use of personal medical and support equipment packed with due regard to how it will be carried

(7)* Traveling through various wilderness environments in which the rescuer could become involved while minimizing threats to safety

(8) Land navigation techniques using map and compass as well as any methods of navigation and position reporting utilized by the responding organizations with which the rescuer could become involved

(9) Procuring the necessary maps and navigational and topographical information
(10) Modifying actions and urgency as applicable to a rescue versus a recovery
(11) Acquiring information on current and forecast weather including temperature, precipitation, and winds
(12)* Participating in and supporting wilderness search operations intended to locate victims whose exact location is unknown
(13) Accessing and extricating individuals from all wilderness environments and terrain encountered in the response area
(14) Recognizing, identifying, and utilizing all rescue hardware and software used by the responding organizations with which the rescuer could become involved
(15) Working in and around any aircraft, watercraft, and special vehicles used for SAR operations while minimizing threats to rescuers
(16)* Recognizing the team's limitations regarding accessing and/or evacuating a victim

10.4 Technician Level.

10.4.1 Organizations operating at the technician level at wilderness search and rescue incidents shall meet the requirements specified in this chapter and the following sections:
(1) Section 6.4 (technician level for rope rescue)
(2) Section 9.2 (awareness level for water search and rescue)

10.4.2 Organizations operating at the technician level shall be capable of performing and supervising all aspects of wilderness search and rescue operations with which the organization could become involved.

10.4.3 Wilderness search and rescue organizations at the technician level shall not be required to develop and maintain capabilities in all types of wilderness search and rescue operations (e.g., search, cave, alpine). The ability of the organization to respond at the technician level in one type of wilderness search and rescue operation shall not imply the ability to respond at the technician level in all types of wilderness search and rescue operations.

10.4.4 Organizations operating at the technician level at wilderness search and rescue incidents shall develop and implement procedures for the following:
(1) Evaluating existing and potential conditions at incidents where wilderness search and rescue will be performed
(2) Acquiring, utilizing, and coordinating search and rescue resources with which the rescuer could become involved
(3) Providing input to standard operating procedures for anticipated wilderness responses
(4)* Initiating and performing all aspects of search and rescue operations in the wilderness
(5)* Writing and utilizing an operational plan for search and rescue

Chapter 11 Trench and Excavation Search and Rescue

11.1 General Requirements.

Organizations operating at trench and excavation incidents shall meet the requirements specified in Chapter 4.

11.2 Awareness Level.

11.2.1 Organizations operating at the awareness level at trench and excavation emergencies shall meet the requirements specified in Sections 11.2 and 7.2 (awareness level for confined space search and rescue).

11.2.2 Each member of the organization shall meet the requirements specified in Chapter 4 of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, and shall be a competent person as defined in 3.3.18.

11.2.3 Organizations operating at the awareness level at trench and excavation emergencies shall implement procedures for the following:

(1) Recognizing the need for a trench and excavation rescue
(2)* Identifying the resources necessary to conduct safe and effective trench and excavation emergency operations
(3)* Initiating the emergency response system for trenches and excavations
(4)* Initiating site control and scene management
(5)* Recognizing general hazards associated with trench and excavation emergency incidents and the procedures necessary to mitigate these hazards within the general rescue area
(6)* Recognizing typical trench and excavation collapse patterns, the reasons trenches and excavations collapse, and the potential for secondary collapse
(7)* Initiating a rapid, nonentry extrication of noninjured or minimally injured victim(s)
(8)* Recognizing the unique hazards associated with the weight of soil and its associated entrapping characteristics

11.3 Operations Level.

11.3.1 Organizations operating at the operations level at trench and excavation emergencies shall meet the requirements specified in Sections 11.2 and 11.3, as well as the following sections:

(1) Section 6.3 (operations level for rope rescue)
(2) Section 7.3 (operations level for confined space search and rescue)
(3) Section 8.3 (operations level for vehicle and machinery search and rescue)

11.3.2* Members shall be capable of recognizing the hazards of using equipment and operating at trench and excavation emergencies that include the collapse or failure of individual, nonintersecting trenches with an initial depth of 2.4 m (8 ft) or less under the following conditions:

(1) No severe environmental conditions exist.
(2) Digging operations do not involve supplemental sheeting and shoring.
(3) Only traditional sheeting and shoring are used.

11.3.3 Organizations operating at the operations level at trench and excavation emergencies shall develop and implement procedures for the following:

(1)* Sizing up existing and potential conditions at trench and excavation emergencies
(2) Initiating entry into a trench or excavation rescue area
(3)* Recognizing unstable areas associated with trench and excavation emergencies and adjacent structures
(4)* Identifying probable victim locations and survivability
(5)* Making the rescue area safe, including the identification, construction, application, limitations, and removal of traditional sheeting and shoring using tabulated data and approved engineering practices
(6)* Initiating a one-call utility location service
(7)* Identifying soil types using accepted visual or manual tests
(8) Ventilating the trench or excavation space
(9) Identifying and recognizing a bell-bottom pier hole excavation and its associated unique hazards

(10) Placing ground pads and protecting the “lip” of a trench or excavation
(11)* Providing entry and egress paths for entry personnel
(12)* Conducting a pre-entry briefing
(13)* Initiating record-keeping and documentation during entry operations
(14) Selecting, utilizing, and applying shield systems
(15)* Selecting, utilizing, and applying sloping and benching systems
(16) Identifying the duties of panel teams, entry teams, and shoring teams
(17) Assessing the mechanism of entrapment and the method of victim removal
(18)* Performing extrication

11.4 Technician Level.

11.4.1 Organizations operating at the technician level at trench and excavation emergencies shall meet the requirements specified in this chapter and the following sections:
(1) Section 7.4 (technician level for confined space search and rescue)
(2) Section 8.4 (technician level for vehicle and machinery search and rescue)

11.4.2* Members shall be capable of recognizing hazards, using equipment, and operating at trench and excavation emergencies that include the collapse or failure of individual or intersecting trenches with an initial depth of more than 2.4 m (8 ft) or where severe environmental conditions exist, digging operations involve supplemental sheeting and shoring, or manufactured trench boxes or isolation devices would be used.

11.4.3 Organizations operating at the technician level at trench and excavation emergencies shall develop and implement procedures for the following:
(1) Evaluating existing and potential conditions at trench and excavation emergencies
(2)* Identifying, constructing, and removing manufactured protective systems consistent with the application and limitations of such systems using tabulated data and approved engineering practices
(3)* Continuously, or at frequent intervals, monitoring the atmosphere in all parts of the trench to be entered for oxygen content, flammability (LEL/LFL), and toxicity, in that order
(4) Identifying the construction, application, limitations, and removal of supplemental sheeting and shoring systems designed to create approved protective systems
(5) Adjusting the protective systems based on digging operations and environmental conditions
(6)* Rigging and placement of isolation systems

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 This standard was developed to define levels of preparation and operational capability that should be achieved by any authority having jurisdiction (AHJ) that has responsibility for technical rescue operations. These defined levels provide an outline of a system used to manage an incident efficiently and effectively, to maximize personnel safety, the successful rescue of victims, and the eventual termination of the event. The system should be followed to increase the capabilities of the AHJ to deal successfully with even the most complex incident. The system progresses from the simple basic awareness level to the operations level, and, finally, to the technician level. It should be understood that, as the system expands, the requirements for training, operational skills, management ability, and types and amounts of equipment also expand.

A.1.1.2 Organizations providing such rescue, fire suppression, and emergency services can include fire departments, law enforcement, emergency medical services, and utility, public works, and rescue organizations.

A.1.2 An organization can achieve its desired level of operational capability through the use of external resources that operate at that desired level.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.9 Avalanche. A small, and often harmless, avalanche is called a "sluff."

A.3.3.10 Belay. This method can be accomplished by a second line in a raising or lowering system or by managing a single line with a friction device in fixed-rope ascent or descent. Belays also protect personnel exposed to the risk of falling who are not otherwise attached to the rope rescue system.

A.3.3.19 Confined Space. This definition excludes mines and caves or other natural formations, all of which must be addressed by other specialized training and equipment.

In addition to those characteristics noted in 3.3.19, a confined space also has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere
(2) Contains a material that has the potential for engulfing an entrant
(3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section
(4) Contains any other recognized serious safety or health hazards (including falling, environmental, and equipment hazards)

A.3.3.36 Entry Permit. An entry permit authorizes specific employees to enter a confined space and contains specific information as required.

In certain industries, U.S. federal law does not require a permit system even though spaces meeting the characteristics of confined spaces as defined within this standard might be present. In these cases, as well as cases of

unauthorized or nonregulated entry into confined spaces, a permit might not be available for reference by the rescue team. The space must be completely assessed before entry can be safely made. U.S. federal law does not require rescuers to have a permit to rescue, although it is advisable for the rescue team to follow similar procedures to ensure safety.

A.3.3.38 Environment. Examples include desert, alpine/mountain, arctic, rain forest, and sea shore.

A.3.3.43 Federal Response Plan. To facilitate the provision of federal assistance, the Federal Response Plan breaks federal response into 12 functions that are called emergency support functions or ESFs (e.g., ESF #9 is urban search and rescue). The plan is designed to address the consequences of any disaster or emergency situation in which there is a need for federal response assistance under authority of the Stafford Act. It is applicable to natural disasters such as earthquakes, hurricanes, typhoons, tornadoes, and volcanic eruptions, as well as technological emergencies involving radiological or hazardous material releases.

A.3.3.44 FEMA Task Force Search and Rescue Marking System. Markings are made by drawing a 0.6 m ×0.6 m (2 ft ×2 ft) "X" and denoting in each of the quadrants of the "X" relevant search information (e.g., search status, findings, hazards found, time and date of search, team involved). Figure A.3.3.44 illustrates the search marking system. For more information, see FEMA *US&R Response System*.

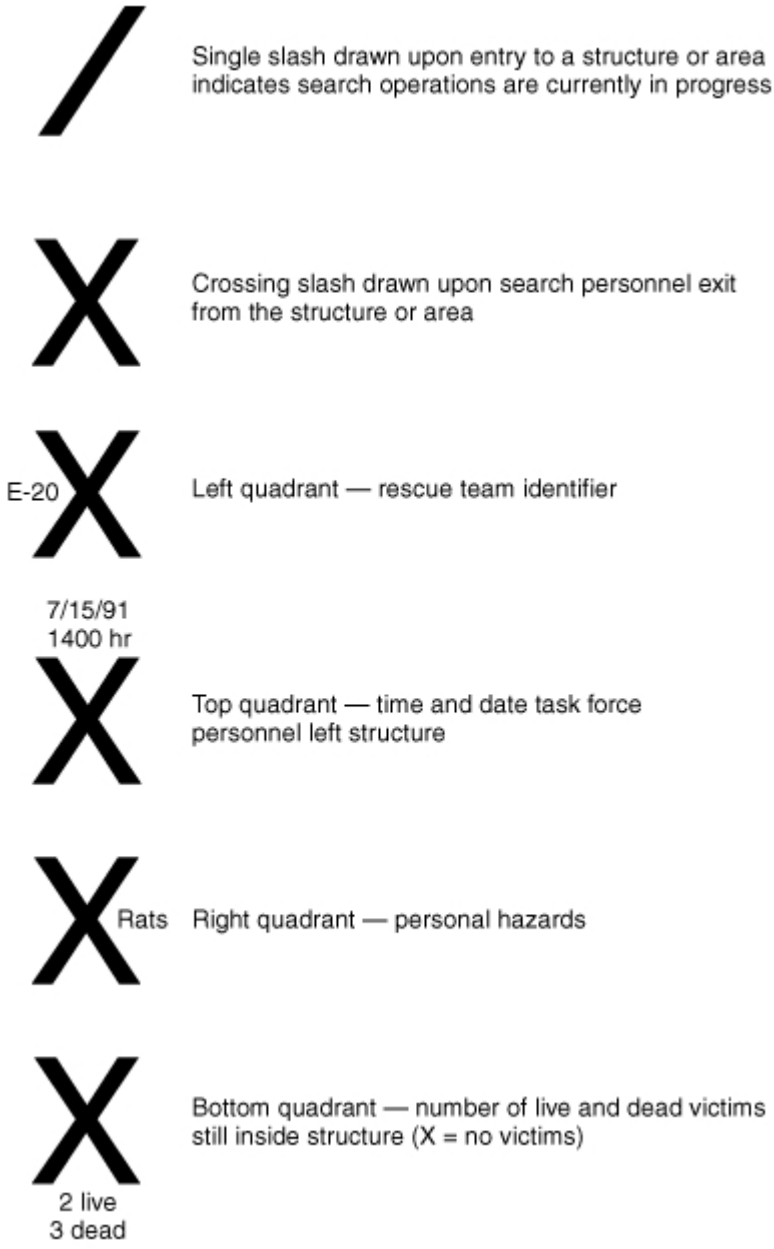


FIGURE A.3.3.44 FEMA Task Force Search and Rescue Marking System.

A.3.3.45 FEMA Task Force Structure/Hazard Evaluation Marking System. Markings are made by drawing a 0.6 m ×0.6 m (2 ft ×2 ft) square box and denoting in and around the box specific relevant hazard information (e.g., general level of operation safety, direction of safest entry, time and date of search, hazards found, team involved). Figure A.3.3.45 illustrates the structure/hazard evaluation marking system. For more information, see FEMA *US&R Response System*.

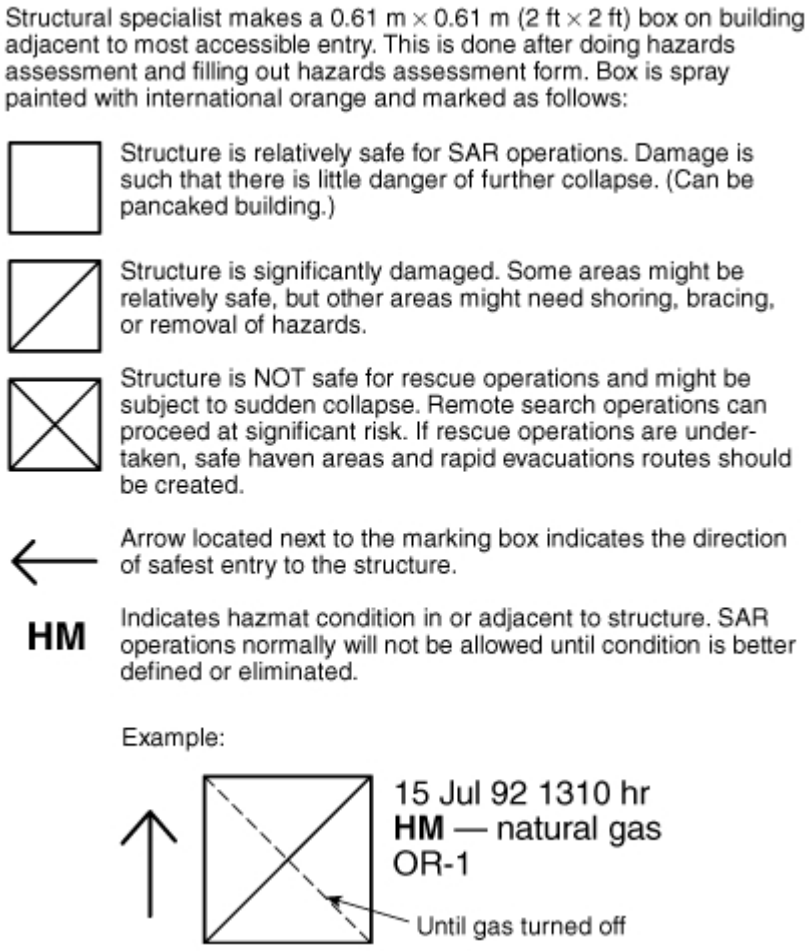


FIGURE A.3.3.45 FEMA Task Force Building Marking System Structure/Hazard Evaluation.

A.3.3.46 FEMA Task Force Structure Marking System, Structure Identification within a Geographic Area. The primary method of identification includes the existing street name, hundred block, and building number. Structure identification within a geographic area is used to differentiate buildings by groups, such as by block(s) or by jurisdictional area. Figure A.3.3.46 illustrates the building ID and location marking system. For more information see FEMA *US&R Response System*, Appendix C, "Task Force Building Marking System."

An important duty of a structure triage team is to clearly differentiate buildings in groupings such as by block(s) or jurisdictional areas/sectors. This geographic (area/sector) identification of buildings would be consolidated at the command post and used to deploy search and rescue personnel and/or track structure/hazard evaluation and search assessment information.

It is imperative that each structure within a geographic area is clearly defined. This identification will assist both in the specific ongoing search and rescue effort and in the long-term post-disaster identification of the site. This identification is important from a technical documentation perspective regarding the specific events that took place at a given site. Structure identification has a significant impact on overall scene safety and the safety of task force personnel.

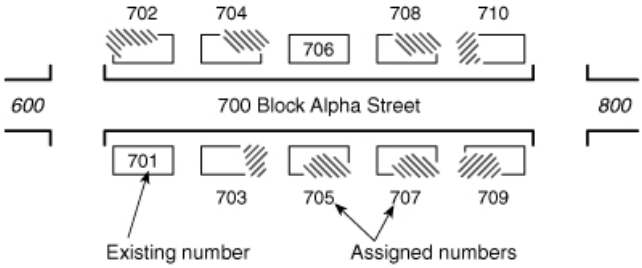
It is important to clearly identify each separate structure within a geographic area when information is being disseminated to other operational entities. The primary method of identification should be the existing street name, hundred block, and building number. Obviously, such identification is not always possible due to post-disaster site conditions. In these situations, it is important that the task force personnel implement the following system for structure identification.

This system builds upon the normal pre-disaster street name, hundred block, and building number. As task force personnel establish a need to identify a structure within a given block they will do the following:

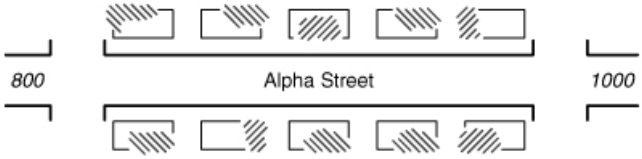
1. Each structure should be identified by existing street name and building number.

2. If some previously existing numbers have been obliterated, an attempt should be made to re-establish the numbering system based upon one or more structures that still display an existing number.

3. The damaged building(s) would be assigned numbers to separately identify them as indicated. The front of the structure(s) in question should be clearly marked with the new numbers being assigned using international orange spray paint.



4. If no number is identifiable in a given block then task force personnel will identify the street name and the hundred block for the area in question on other structures in proximity to the site in question.



5. In this case, structures will be assigned the appropriate numbers to designate and differentiate them. The front of the structure(s) in question should be clearly marked with the new number being assigned using international orange spray paint.

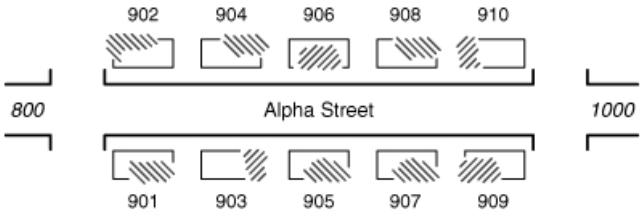


FIGURE A.3.3.46 FEMA Task Force Structure Marking System Structure Identification Within a Geographic Area.

A.3.3.50 General Area. The general area is sometimes referred to as the warm zone and is usually the area 90 m (300 ft) in all directions from the incident site.

A.3.3.65 Incident Scene. The incident scene includes the entire area subject to incident-related hazards and all areas used by incident personnel and equipment in proximity to the incident.

A.3.3.66 Isolation System (or Isolation Devices). Examples of isolation devices include concrete or steel pipe, corrugated pipe, concrete vaults, or other pre-engineered structures that sufficiently isolate and protect the victim.

A.3.3.67 Knot. Knots include bights, bends, and hitches.

A.3.3.73 Load. Some examples include a rescue subject, a rescuer, and subjects in a litter with a litter attendant.

A.3.3.74 Lockout. Usually a disconnect switch, circuit breaker, valve, or other energy-isolating mechanism is used to hold equipment in a safe position. It can include the use of guards when other mechanisms are not available. However, the use of guards can violate federal lockout/tagout regulations in federally regulated facilities. Lockout is usually performed in combination with a tagout procedure.

A.3.3.76 Lowering System. Lowering systems should incorporate a mechanism to prevent the uncontrolled descent of the load during the lowering operation. This mechanism can reduce the need for excessive physical force to control the lowering operation.

A.3.3.79 Mechanical Advantage (M/A). For example, a rope mechanical advantage system that requires only 4.54 kg (10 lb) of input force to produce 13.6 kg (30 lb) of output force has a 3:1 mechanical advantage [13.61 kgf (301 lbf), 3:1]. Likewise, a system that requires 13.6 kg (30 lb) of input force to produce 13.6 kg (30 lb) of output force has a 1:1 mechanical advantage. There is no such thing as zero mechanical advantage. Other factors can affect the efficiency of a mechanical advantage system, including friction and drag created by the equipment. For purposes of this document, these factors are not considered and so the mechanical advantage is theoretical rather than actual. Although other classifications exist, rope-based mechanical advantage systems are most practically classified as simple or compound.

A.3.3.80 National Search and Rescue Plan. According to this plan, all maritime or navigable water search and rescue (SAR) is the responsibility of the U.S. Coast Guard, and all inland SAR is the responsibility of the U.S. Air Force.

A.3.3.87 Personal Protective Equipment (PPE). PPE includes protective apparel (e.g., clothing, footwear, gloves, and headgear) as well as personal protective devices (e.g., goggles, face shields, hearing protectors, and respirators). Adequate PPE should protect the respiratory system, skin, eyes, face, hands, feet, body, and ears.

A.3.3.92 Protective System. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

A.3.3.96 Raising System. Raising systems should incorporate a mechanical means to prevent the load from falling should the primary control mechanism be released during the raising operation.

A.3.3.100 Registered Professional Engineer. A registered professional engineer registered in any state is deemed to be a “registered professional engineer” within the meaning of this standard when approving designs for manufactured protective systems or tabulated data to be used in the construction of protective systems.

A.3.3.102 Rescue Area. Sometimes rescue area is generally defined as an area 15 m (50 ft) in all directions from the incident site, or a distance in all directions equal to the height of the structure involved in the collapse plus a third.

A.3.3.109 Retrieval System. In U.S. federally regulated industrial facilities, these systems are required whenever an authorized entrant enters a confined space unless the retrieval system would increase the overall risk of entry or would not contribute to the rescue of the entrant. For confined space rescue operations, these systems should be in place prior to entry (into vertical or horizontal spaces) in such a manner that retrieval of rescue entrants can begin immediately in the event of an emergency. Retrieval systems can also be used to act as fall-arresting devices for rescue personnel.

A.3.3.112 Risk/Benefit Analysis. Traditionally in search and rescue, this analysis involves the assessment of the general status of the victim(s) in order to apply the proper urgency to the situation (rescue versus body recovery). A live victim suggests a rescue and its associated high level of urgency. A deceased victim, however, requires a body recovery, which suggests a far less urgent response.

A.3.3.121 Shield (or Shield System). Shields can be permanent structures that are designed to be portable and moved along. Shields can be either manufactured or job-built in accordance with 29 CFR 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

A.3.3.131 Strongback. Uprights placed so that the individual members are closely spaced, in contact with, or interconnected to each other are considered "sheeting."

A.3.3.132 Supplemental Sheeting and Shoring. Supplemental sheeting and shoring requires additional training beyond that of traditional sheeting and shoring.

A.3.3.136 System Safety Factor. In a system where the weakest point has a component minimum breaking strength of 36 kN (≅ 8,000 lbf) as compared to 3.6 kN (≅ 800 lbf) force placed upon it, the resulting system safety factor is 10:1 (e.g., 8,000 lbf:800 lbf = 10:1).

A.3.3.138 Tabulated Data. The term is also applied to six tables found in Appendix C of 29 CFR 1926, Subpart P.

A.3.3.141 Technical Rescue Incident. Technical rescue incidents can include water rescue, rope rescue, confined space rescue, wilderness search and rescue, trench rescue, vehicle and machinery rescue, dive search and rescue, collapse rescue, and other rescue operations requiring specialized training.

A.3.3.144 Terrain. Examples include cliffs, steep slopes, rivers, streams, valleys, fields, mountainsides, and beaches.

A.3.3.145 Terrain Hazard. Examples include cliffs, caves, wells, mines, avalanches, and rock slides.

A.3.3.147 Traditional Sheeting and Shoring. Some newer style sheeting and shoring might not require a strongback attachment (refer to manufacturer recommendations).

A.3.3.150 Trench (or Trench Excavation). In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is no greater than 4.6 m (15 ft). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 4.6 m (15 ft) or less, the excavation is also considered a trench.

A.3.3.154 Wilderness. The wilderness often includes a collection of various environments such as forests, mountains, deserts, natural parks, animal refuges, rain forests, and so forth. Depending on terrain and environmental factors, the wilderness can be as little as a few minutes into the backcountry or less than a few feet off the roadway. Incidents with only a short access time could require an extended evacuation and thus qualify as a wilderness incident.

A.4.1.1 Safe operations at technical rescue incidents should include the assessment and acquisition of external resources required for situations beyond the operational capability of the organization. For example, a situation in a confined space or trench might require a technician-level hazardous materials response capability.

A.4.1.2(1) This level can involve search, rescue, and recovery operations. Members of a team at this level are generally not considered rescuers.

A.4.1.2(2) This level can involve search, rescue, and recovery operations, but usually operations are carried out under the supervision of technician-level personnel.

A.4.1.6 BLS is the minimum level of medical care required; advanced life support (ALS) is recommended. The AHJ should consider the development of an advanced capability in medical response to reflect the needs of the technical rescue environment.

The AHJ, in addition to BLS training, should provide training in the treatment of the following medical conditions:

(1) *Cervical/Spinal Immobilization.* Training should be integrated with systems for vertical and horizontal patient evacuations (e.g., patient packaged onto a stokes stretcher and secured to provide spinal immobilization).

(2) *Crush Injury Syndrome.* Training should include recognition, evaluation, and treatment, prior to extrication, of victims with symptoms or mechanisms of injury potential.

(3) *Amputation.* Amputation should be considered as a last resort, but rescuers should be aware of the possibility. Incident managers also should be aware of the proper procedures to be followed in their community, including interaction with local medical doctors.

(4) *Infection Control.* Training should include education in protective equipment (e.g., gloves, masks, PPE), protective procedures (e.g., avoiding contaminants and pollutants), and appropriate decontamination following possible exposures, as specified in NFPA 1581, *Standard on Fire Department Infection Control Program*, or in OSHA's "Blood-Borne Pathogens" standard (29 CFR 1910.1030).

(5) *Critical Incident Stress.* Training should include information on personal well-being, with emphasis on preconditioning, pacing of effort, proper diet and rest, and emotional and psychological diversions during long-term operations. Personnel should be trained to recognize the signs and symptoms of critical incident stress. Scene managers should be trained in the value of rehabilitation efforts during extended operations for the safety and continued efficiency of their personnel.

A.4.1.7.2 Organizations should provide ongoing training commensurate with proficiency to the identified operational level of capability in each applicable technical search and rescue discipline. The amount and frequency of this continuing education required is commonly based on criteria such as the current competency and aptitude of the team, fiscal constraints, and time constraints. However, this standard provides that the AHJ utilize performance-based evaluation as the primary basis for the amount and frequency of training required to meet this standard. Organizations demonstrating poor performance during evaluation imply a need for a greater amount and/or frequency of training.

A.4.1.7.4 In all types of search and rescue incidents, the potential exists for extenuating circumstances that would require expertise beyond the normal capability of the organization to operate safely. Examples of these situations include, but are not limited to, the following:

(1) Structural Collapse: Multiple collapse sites, large number of victims, numerous deeply buried victims, multiple complications (e.g., both deeply buried victims and multiple sites), involvement of hazardous/toxic substances, or severe environmental conditions (e.g., snow and rain)

(2) Rope Rescue: Lowering and raising operations requiring significant obstacle negotiation, descending or ascending operations from extreme heights, or severe environmental conditions (e.g., snow and rain)

(3) Confined Space Search and Rescue: Deep or isolated spaces, multiple complicating hazards (e.g., water, chemicals, and extreme height in a space), failure of essential equipment, or severe environmental conditions (e.g., snow and rain)

(4) Vehicle and Machinery Search and Rescue: Complex and/or unusual machinery, unusual vehicles, unusual locations of either machinery or vehicles, multiple complicating hazards (e.g., water, chemicals, and extreme height), failure of essential equipment, or severe environmental conditions (e.g., snow and rain)

(5) Water Search and Rescue: Depth, current, water movement, water temperature extremes, or severe environmental conditions (e.g., snow and rain)

(6) Wilderness Search and Rescue: Isolated and remote environments and extremes of environmental conditions (e.g. snow, rain, altitude)

(7) Trench and Excavation Search and Rescue: Very deep trenches, unusually shaped excavations, multiple complications (e.g., deep excavation and fluid soil), involvement of hazardous/toxic substances, completely buried subjects, or severe environmental conditions (e.g., snow and rain)

These conditions should be evaluated during the pre-incident risk assessment and on an incident-by-incident basis.

A.4.1.7.5 This documentation should contain each recipient's name, the signatures or initials of the trainers, the dates of training, an outline of the training conducted, and resource materials used to develop the training.

A.4.1.10 Legal considerations have an impact on many phases of a technical rescue incident (e.g., confined space regulations, use/maintenance of SCBA, right-of-entry laws during a search, right-to-privacy laws during an investigation). Whatever the capacity in which a rescuer functions (public or private), it is important that the rescuer be informed regarding all relevant legal restrictions, requirements, obligations, standards, and duties. Failure to do so could jeopardize the reliability of any investigation or operation and could subject the rescuer to civil liability or criminal prosecution.

A.4.1.11 Personnel involved in search and rescue (SAR) in the United States should also familiarize themselves with the *International Aeronautical and Maritime Search and Rescue Manual* (IAMSAR) and the *U.S. National Search and Rescue Supplement* (NSS) *to the IAMSAR*. Both of these documents, as well as the *U.S. National Search and Rescue Manual,* are available on the U.S. Coast Guard's web site (www.uscg.mil). The *Federal Response Plan* is available on the FEMA web site (www.fema.gov/library/di2).

The IAMSAR is a three-volume set of reference materials jointly published by the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). It was intended for use by all countries and provides implementation guidance for the U.S. National Search and Rescue Plan (1999).

The NSS, prepared under the direction of the National Search and Rescue Committee (NSARC), provides guidance to federal agencies concerning implementation of the National Search and Rescue Plan. The NSS provides specific additional national standards and guidance that build upon the baseline established in the IAMSAR and provides guidance to all federal forces, military and civilian, that support civil search and rescue operations.

A.4.2.1 A hazard identification and risk assessment is an evaluation and analysis of the environment and physical factors influencing the scope, frequency, and magnitude of technical rescue incidents and the impact and influence they can have on the ability of the AHJ to respond to and safely operate at these incidents.

The goal and terminal objectives of the hazard identification and risk assessment are to increase the awareness of the AHJ and to provide a focus toward conditions and factors associated with potential technical rescue responses.

The hazard identification and risk assessment can be associated closely with similar functional and format methodology, as might be incorporated in a master plan or strategic deployment study. It is not the intent of this standard to encumber the AHJ in its undertaking of a detailed and extensive analysis of each technical rescue environment within the jurisdiction; rather, this standard is meant to provide means for a deliberate and objective examination of common or unique factors that can be identified, correlated, or highlighted to aid in the development of technical rescue capabilities and to determine their necessary level of expertise to provide risk reduction.

The hazard identification and risk assessment determines "what" can occur, "when" (how often) it is likely to occur, and "how bad" the effects could be. For certain of the hazards identified, it will be determined after this preliminary analysis that it is not necessary to carry out a full analysis. For such hazards, no further action is required.

The hazard identification should include, but not be limited to, the following types of potential hazards:

(1) Natural events
- (a) Drought
- (b) Fire (forest, range, urban)
- (c) Avalanche
- (d) Snow/ice/hail
- (e) Tsunami
- (f) Windstorm/tropical storm
- (g) Hurricane/typhoon/cyclone
- (h) Biological
- (i) Extreme heat/cold
- (j) Flood/wind-driven water
- (k) Earthquake/land shift
- (l) Volcanic eruption
- (m) Tornado
- (n) Landslide/mudslide
- (o) Dust/sand storm
- (p) Lightning storm

(2) Technological events
- (a) Hazardous material release
- (b) Explosion/fire
- (c) Transportation accident
- (d) Building/structure collapse
- (e) Power/utility failure
- (f) Extreme air pollution
- (g) Radiological accident
- (h) Dam/levee failure
- (i) Fuel/resource shortage
- (j) Business interruption
- (k) Financial collapse

(l) Communication

(3) Human events
   (a) Economic
   (b) General strike
   (c) Terrorism (eco, cyber, nuclear, biological, and chemical)
   (d) Sabotage
   (e) Hostage situation(s)
   (f) Civil unrest
   (g) Enemy attack
   (h) Arson
   (i) Community-wide panic
   (j) Special events

There are a number of methodologies and techniques for risk assessment that range from simple to complex. These techniques include, but are not limited to, the following:

(1) What-if
(2) Checklist
(3) Hazop, hazard, and operability studies
(4) Failure modes and effect analysis
(5) Fault tree
(6) Failure-logic diagrams
(7) Dow and bond indices
(8) Event tree analysis
(9) Human reliability analysis
(10) Capability assessment readiness for state and local governments

A.4.2.3 As part of the risk assessment, the AHJ should identify the types of internal resources immediately available, within the operational structure of the organization, that could be utilized for technical search and rescue incident response. The resource list should include the availability of personnel, training levels of personnel, professional specialty or trade skills, and type, quantity, and location of equipment, appliances, and tools applicable to technical search and rescue incident response.

A.4.2.4 See Annex E.

A.4.2.5 The intent of this provision is to establish procedures to enable the incident commander to obtain the necessary resources to augment the internal capabilities of the AHJ. These resources can include, but are not limited to, the following:

(1) Mutual aid agreements
(2) Agreements with the private sector, including the following:
   (a) Organizations specializing in the specific skills and/or equipment required to resolve the incident
   (b) Special equipment supply companies
   (c) Related technical specialists
   (d) Communications
   (e) Food service
   (f) Sanitation
(3) Memorandums of Agreement (MOA) with other public, state, or federal agencies

A.4.4.1.1 Specific specialized equipment that might be required for safe technical rescue operations includes the following:

(1) Supplied line breathing apparatus (SLBA), supplied air breathing apparatus (SABA), and supplied air respirator (SAR), all of which should meet the requirements of 29 CFR 1910.146, “Permit-Required Confined Spaces”

(2) Personal alert safety system (PASS), which should meet the requirements of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*

(3) Life safety ropes and system components, which should meet the requirements of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1983, *Standard on Fire Service Life Safety Rope and System Components*

(4) Communications equipment, which should meet the requirements of 29 CFR 1910.146

(5) Lighting equipment (e.g., flashlights, helmet-mounted lamps), which should be, depending on the situation, intrinsically safe or explosionproof as defined by 29 CFR 1910.146. The AHJ should evaluate the appropriateness of the equipment at an emergency incident with regard to the existing hazards.

A.4.4.2.1 Protective equipment should be appropriate to the tasks that are expected to be performed during technical search and rescue incidents and training exercises.

A.4.5.1.4 BLS is the minimum level required; ALS is recommended.

A.4.5.1.5 Interagency cooperation is essential to the successful mitigation of many technical rescue incidents. Personnel from fire, rescue, EMS, and law enforcement can be involved in an operation at all levels, from recognition through command. It is recommended that all agencies involved in rescue review and/or develop policies regarding control of firearms. The complete exclusion of firearms might not always be practical and/or feasible on the incident scene but is generally recommended.

A.4.5.3.1 The incident management system utilized at all technical search and rescue incidents should be structured to address the unique groups, divisions, or branches that can be necessary to effectively manage the specific type of incident (e.g., structural collapse, trench/excavation cave-in). Managing external influences such as family, news media, and political entities involves instructing subordinates in how to deal with them should they be encountered. NFPA 1561, *Standard on Emergency Services Incident Management System*, in 5.2.2, describes the use of an information officer (a member of the command staff) to address these types of influences. Where encounters with family, news media, or political influences are likely, such a function should be filled as soon as possible.

A.4.5.4 The AHJ should address the possibility of members of the organization having physical and/or psychological disorders (e.g., physical disabilities, fear of heights, fear of enclosed spaces) that can impair their ability to perform search and rescue in a specific environment.

Organizations are encouraged to adopt language similar to that included in Chapter 10, Medical and Physical Requirements, of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, regarding their medical and physical requirements.

A.4.5.5.1 These incidents can be caused by natural, accidental, or intentional means.

A.5.2.2(2) The intent of this provision is to establish procedures to enable the incident commander to obtain the necessary resources to augment the internal capabilities of the AHJ. These resources can include, but are not limited to, the following:

(1) Mutual aid agreements

(2) Agreements with the private sector, including the following:
   (a) Construction industry
   (b) Demolition industry
   (c) Heavy equipment operators
   (d) Special equipment supply companies
   (e) Hardware, lumber, and construction suppliers
   (f) Consulting engineers and architects
   (g) Related technical specialists
   (h) Communications
   (i) Food service
   (j) Sanitation

(3) Memorandums of Agreement (MOA) with other public, state, or federal agencies

A.5.2.2(3) The emergency response system includes, but is not limited to, operations- and technician-level personnel, as well as local, state, and national resources.

A.5.2.2(4) These procedures should include the process of achieving and maintaining control of the site and the perimeter. This activity might include management of all civilian and nonemergency personnel and establishment of operational zones and site security.

A.5.2.2(5) See Annex F.

A.5.2.2(6) Collapse patterns and potential victim locations include the following:

(1) *Lean-to.* A lean-to is formed when one or more of the supporting walls or floor joists breaks or separates at one end, causing one end of the floor(s) to rest on the lower floor(s) or collapse debris. Potential areas where victims might be located are under the suspended floor and on top of the floor at the lowest level. *[See Figure A.5.2.2(6)(a).]*

(2) *V.* A "V" is formed when heavy loads cause the floor(s) to collapse near the center. Potential areas where victims might be located are under the two suspended floor pieces and on top of the floor in the middle of the V. *[See Figure A.5.2.2(6)(b).]*

(3) *Pancake.* A pancake is formed when the bearing wall(s) or column(s) fails completely and an upper floor(s) drops onto a lower floor(s), causing it to collapse in a similar manner. Potential areas where victims might be located are under the floors and in voids formed by building contents and debris wedged between the floors. *[See Figure A.5.2.2(6)(c).]*

(4) *Cantilever.* A cantilever is formed when one end of the floor(s) hangs free because one or more walls have failed and the other end of the floor(s) is still attached to the wall(s). Potential areas where victims might be located are on top of or under the floors. *[See Figure A.5.2.2(6)(d).]*

(5) *A-frame.* An A-frame occurs when flooring separates from the exterior bearing walls but still is supported by one or more interior bearing walls or nonbearing partitions. The highest survival rate for trapped victims will be near the interior partitioning. Other victims will be located in the debris near both exterior walls. *[See Figure A.5.2.2(6)(e).]*

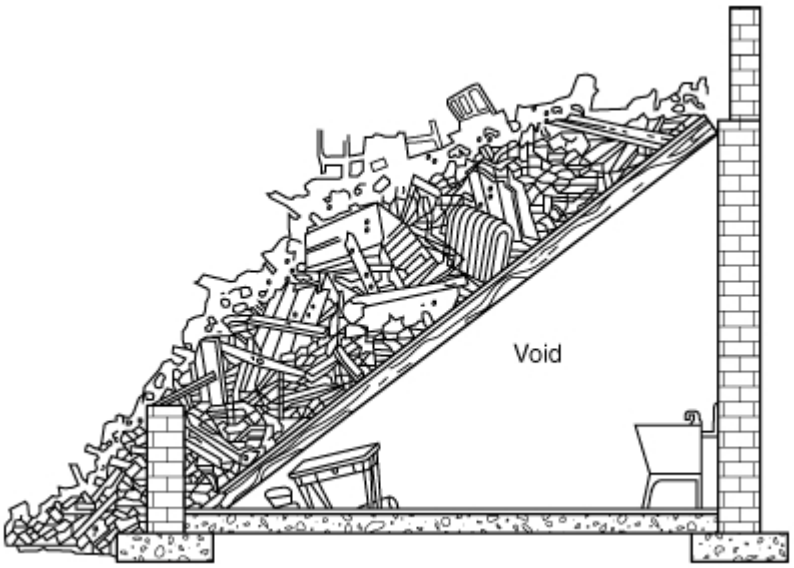


FIGURE A.5.2.2(6)(a) Lean-to Floor Collapse. ***(Courtesy of U.S. Department of Civil Defense)***

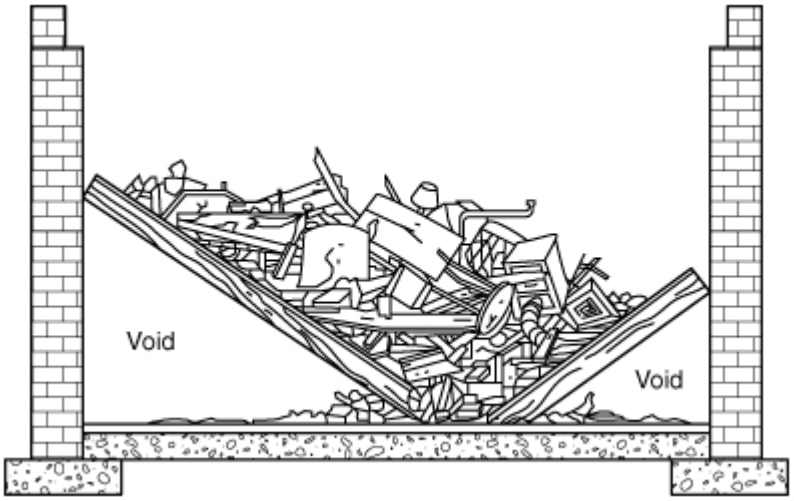


FIGURE A.5.2.2(6)(b) V-Shape Floor Collapse. ***(Courtesy of U.S. Department of Civil Defense)***

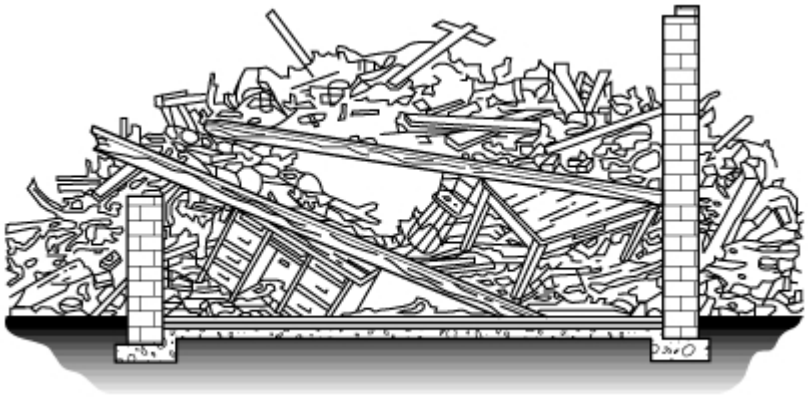


FIGURE A.5.2.2(6)(c) Pancake Floor Collapse. ***(Courtesy of U.S. Department of Civil Defense)***

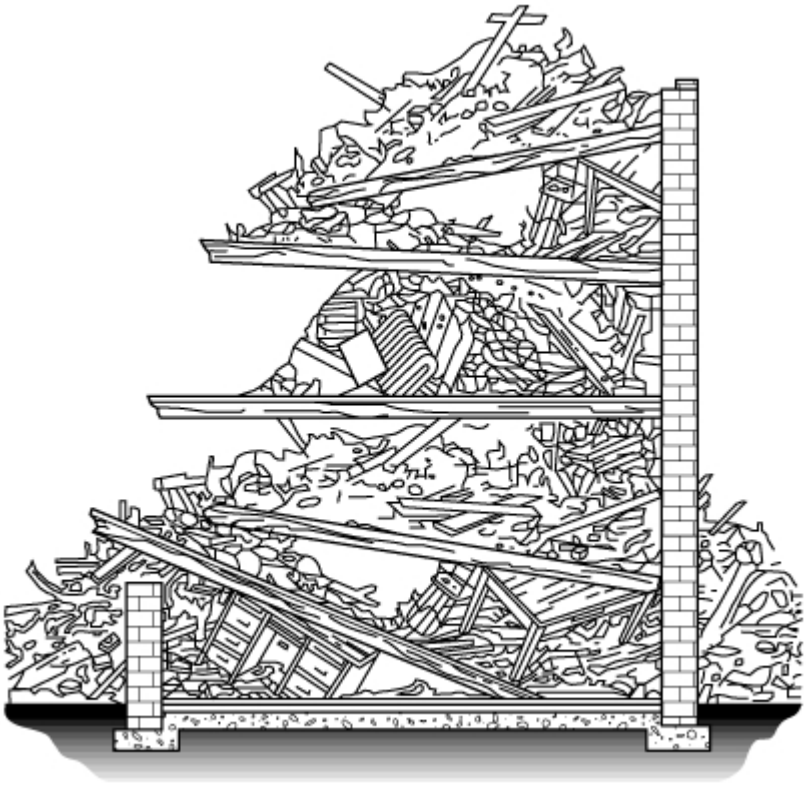


FIGURE A.5.2.2(6)(d) Cantilever Floor Collapse. ***(Courtesy of U.S. Department of Civil Defense)***

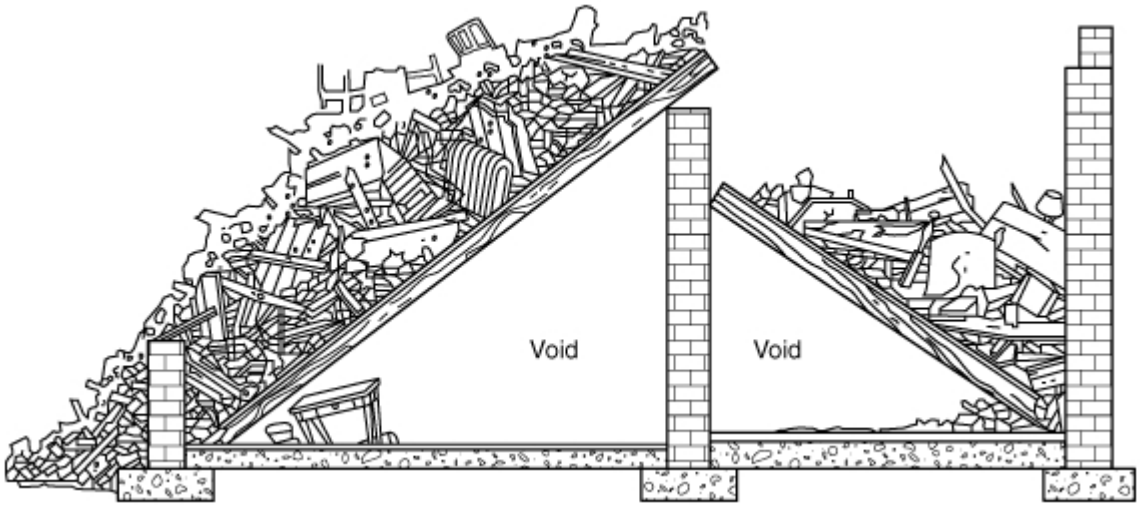


FIGURE A.5.2.2(6)(e) A-Frame Floor Collapse.

A.5.2.2(7) Indications of potential for secondary collapse include the following:

(1) Leaning walls
(2) Smoke or water seeping through joints
(3) Unusual sounds (e.g., creaking, groaning)
(4) Recurring aftershocks
(5) Sagging floor or roof assemblies
(6) Missing, strained, or damaged points of connection of structural elements
(7) Excessive loading of structural elements
(8) Sliding plaster and airborne dust
(9) Separating walls
(10) Lack of water runoff

(11) Racked or twisted structure
(12) Building vibration

A.5.2.2(8) Procedures for conducting searches should include, at a minimum, visual and verbal methods.

Search and rescue operations in the structural collapse environment should include close interaction of all incident management system elements for safe and effective victim extrications. Search operations for locating victims should be initiated early at a structural collapse incident. Structural collapse search operations should conform to an accepted system for victim search strategy and tactics to achieve optimum performance and effectiveness. The following recommendations provide current tactical capabilities and general strategies that can assist personnel in productive search operations.

Structural collapse operations are one of the most difficult rescue situations likely to be encountered. Depending on the complexity of the search and rescue activity, personnel might need to spend large amounts of precious time on small numbers of difficult rescues. It is important to establish whether or not rescue personnel are involved with a live victim, since the rescue of living victims should be prioritized ahead of the recovery of the remains of deceased victims.

A.5.2.2(9) See Annex G.

A.5.3.3(1) The size-up should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Scope and magnitude of the incident
(2) Risk assessment and benefit analysis
(3) Number and size of structures affected
(4) Integrity and stability of structures affected
(5) Occupancy types (e.g., residential, mercantile)
(6) Number of known and potential victims
(7) Access to the scene
(8) Environmental factors
(9) Available and necessary resources

A.5.3.3(3) Operations personnel should be capable of obtaining and utilizing one or more of the following resources:

(1) Structural collapse search dogs
(2) Search cameras
(3) Acoustic/seismic instruments (listening devices)
(4) Thermal imaging (infrared) devices
(5) Other technical search devices

Search operations should incorporate a variety of technical and nontechnical methods that might provide personnel with the only viable method to locate victims and determine their status.

The AHJ should identify forms of technical and nontechnical search capabilities available at the local, regional, state, or national level that are commensurate with its needs. In addition to the basic operational level of capability, search methods should include, but not be limited to, the following:

(1) *Structural Collapse Search Dogs.* This involves the use of air-scent dog and handler teams trained and equipped specifically to search collapsed structures. The dog and handler work as a team to identify the location and status of victims buried beneath rubble or structural components. It is important that the AHJ differentiate between structural collapse search dogs and other "air-scenting" dogs such as those used to search for drugs and explosives, cadaver dogs, and police K-9.
(2) *Electronic Search.* This involves the use of acoustic/seismic devices and includes the deployment of an array of two or more pickup probes around the perimeter of a collapsed structure or void area.
(3) *Search Cameras.* This involves the placement of a search camera device within a void area to search "visually" a previously nonvisible collapse zone. To use this device, ancillary tools such as rotary hammers, drills, or breakers are needed to create an opening through which the camera can be passed.
(4) *Air Sampling.* Identification of high concentrations of CO_2, for example, might indicate the presence of a live victim. Once the AHJ has identified the location and availability of these search options at a structural

collapse incident, a system should be developed to place them into operation. In conjunction with the capability of the AHJ to place into operation one or more of the previously described search methods, personnel should implement a strategic and tactical plan for the use of these devices as quickly as possible. Personnel should coordinate all available and viable tactical capabilities into a logical plan of operation. It is essential that the AHJ employ every possible search method to ensure that its members are able to locate viable victims before committing rescue resources to any prolonged (even if well-intentioned) operation.

A.5.3.3(4) Access training should include, but not be limited to, the safe and effective implementation of the following:

(1) Techniques to lift structural components of walls, floors, or roofs
(2) Shoring techniques to construct temporary structures needed to stabilize and support structural components that prevent movement of walls, floors, or roofs
(3) Breaching techniques to create openings in structural components of walls, floors, or roofs
(4) Operation of appropriate tools and equipment to accomplish the above tasks

A.5.3.3(5) Extrication operations at a structural collapse incident necessitate a coordinated effort that includes search, rescue, and medical capabilities. Personnel should have a working knowledge of general extrication tactics and procedures. These tactics and procedures should be flexible enough to address the specific situation and problems encountered. The AHJ should provide the appropriate training and equipment necessary to complete an extrication operation safely and effectively. These should include the following:

(1) *Manual.* Training should be provided in safe lifting techniques necessary to move manageable sections of debris and interior contents displaced by partial or complete structural collapse.
(2) *Hand Tools.* Tools and training necessary to move debris, room contents, and structural components displaced by partial or complete structural collapse should be provided. Hand tools should include, but not be limited to, pry bars, bolt cutters, jacks, and sledge hammers. Training requirements should be coordinated with the hand tool inventory.

Extrication training should include the following, as a minimum:

(1) Packaging victims within confined areas
(2) Removing victims from elevated or belowgrade areas
(3) Providing initial medical treatment to victims
(4) Operating appropriate tools and equipment to accomplish the above tasks safely and effectively

A.5.4.3(3) See A.5.3.3(3).

A.5.4.3(4) Generally in concrete tilt-up, reinforced concrete, and steel construction, locating and extricating victims is more complicated than in light-frame, ordinary construction or reinforced and unreinforced masonry construction. As structural components, materials, and weights increase, the ability to breach, stabilize, and operate within such a structural collapse becomes more hazardous, complicated, and time-consuming.

The overall ability of the AHJ to function safely and effectively is greatly dependent upon the prompt availability of appropriate tools, equipment, and supplies to accomplish operations. In concrete tilt-up, reinforced concrete, and steel construction, personnel should understand that the tools that are needed change depending on the type of structure involved. Structural collapse incidents involving these categories of construction necessitate the use of tools and equipment specifically designed for these materials, including the following:

(1) Masonry saws and blades
(2) Rotary hammers and breakers
(3) Air bags
(4) Dump trucks and front-end loaders
(5) Concrete saws and blades
(6) Pneumatic and hydraulic drills, hammers, and breakers
(7) Cranes
(8) Burning and cutting equipment such as oxyacetylene and exothermic or plasma cutters

(9) Bolting and anchoring systems

Power tools (e.g., air bags, hydraulic spreaders and rams, and power saws) and training necessary to breach, cut, bore, and lift structural components displaced by partial or total structural collapse should be provided.

A.5.4.3(5) See A.5.3.3(5).

A.6.1.2 While rope rescues by themselves do not generally involve searches, it is appropriate for the AHJ to consider the environment in which rope rescues might occur and to assess the relative need. Efforts to locate missing persons in the high- and low-angle environment, both structural collapse and wilderness, are covered in Chapter 5 and Chapter 10, respectively, of this document. Victims that require removal from elevated and belowgrade locations (confined space, structural collapse, and water rescue), once located, might then require the capabilities of rope rescue stated within this chapter.

A.6.2.2(2) See A.5.2.2(2).

A.6.2.2(3) The emergency response system includes, but is not limited to, operations- and technician-level personnel capable of responding, as well as local, state, and national resources.

A.6.2.2(4) These procedures should include the process of achieving and maintaining control of the site and the perimeter. This process might include management of all civilian and nonemergency personnel and establishment of operational zones and site security.

A.6.2.2(5) General hazards associated with rope rescue operations can present the AHJ with uniquely challenging situations. The AHJ should consider the following potential hazards when providing training to its members:

(1) *Fall Hazards.* Rope rescue incidents are often required in areas where an elevation differential exists. Therefore, the possibility of someone falling, or something falling on someone, should always be considered and mitigated.

(2) *Other Hazards.* There are numerous other hazards associated with rope rescue operations. The AHJ should make every effort to identify the hazards that might be encountered within the jurisdiction and should provide members with training and awareness of these other hazards to perform rescue operations safely and effectively.

The "general area" around a rope rescue scene is the entire area within 91.44 m (300 ft) (or more, as established by the incident commander). Making the general area safe includes, but is not necessarily limited to, the following:

(1) Controlling/limiting traffic and sources of vibration in the area, including shutting down all vehicles and equipment

(2) Controlling/limiting access to the area by unnecessary personnel

(3) Identifying hazards and removing and/or reducing their impact

A.6.2.2(6) Other than that described in 4.4.2, specific PPE necessary for safe rope rescue operations can include, but is not limited to, the following:

(1) Harnesses

(2) Gloves appropriate for rope rescue work

(3) Helmets designed for climbing and rope rescue work

A.6.3.4(1) The size-up should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Scope, magnitude, and nature of the incident

(2) Location and number of victims

(3) Risk assessment versus benefit analysis (body recovery versus rescue)

(4) Access to the scene

(5) Environmental factors

(6) Available/necessary resources

(7) Patient contact when it can be performed without endangering either responders or victims

A.6.3.4(2) Safety procedures should include, as a minimum, the following:

(1) Edge protection

(2) Belays

(3) Critical angles in rope systems
(4) System stresses
(5) Safety checks
(6) Other safety assurances

A.6.3.4(5) Rescuers should be able to identify a tied knot. Specific knots, hitches, and bends that can be useful include the following:

(1) Bowline
(2) Figure-eight family of knots and bends
(3) Grapevine or double fisherman's knot
(4) Water knot
(5) Barrel knot
(6) Any knots, hitches, or bends used by the organization

A.6.3.4(7) NFPA 1983, *Standard on Fire Service Life Safety Rope and System Components*, includes information on the marking and labeling of rope rescue equipment. An understanding of how minimum breaking strength ratings are arrived at and the significance of the P, L, and G rating system for rope rescue components found in that document is critical knowledge in estimating system safety factors.

A.6.3.4(8) An "anchor system" includes, if necessary, an appropriate and proper backup. Anchor systems can include, but are not limited to, the use of portable anchor systems (either improvised or commercial) such as A-frames, bipods, tripods, pickets, and gin poles.

A.6.3.4(13) The skills and procedures required to select, construct, and use a lowering system vary greatly depending on environmental factors and elevation differential (height). Therefore, rescuers should be trained to perform these procedures under all potential environmental (e.g., snow, darkness, wind) and elevation conditions.

A.6.3.4(18) One type of raising system is a counterbalance system, which uses a 1:1 mechanical advantage and a weighted object (human or otherwise) to reduce the need for additional force to lift the load.

A.6.3.5(1) See A.6.3.4(1).

A.6.3.5(2) See A.6.3.4(2).

A.6.3.5(5) See A.6.3.4(5).

A.6.3.5(7) See A.6.3.4(7).

A.6.3.5(8) See A.6.3.4(8).

A.6.3.5(13) See A.6.3.4(13).

A.6.3.5(18) See A.6.3.4(18).

A.7.1.2 While much of this chapter applies to confined space rescue in industrial settings, it is intended for all incidents involving confined spaces as defined within this standard.

A.7.1.3.8 The term *timely* is based on many factors such as perceived danger of the original entry (e.g., possible supplied breathing air required), distance to definitive medical care, capabilities of responding emergency medical services, and so forth. In trauma-related injuries, the "golden hour" principle can be used to determine how quickly the rescue service should be able to respond to deliver the patient to the appropriate treatment facility within an hour of onset of injuries. The rescue service should have a goal of responding to these emergencies within 15 minutes of the time they receive notification.

A.7.2.4(3) Hazards can include, but are not limited to, the following:

(1) Hazardous atmospheres
(2) Hazardous chemicals
(3) Temperature extremes

Some methods of recognition and assessment of hazards associated with confined spaces include, but are not limited to, the following:

(1) Assessment of the perimeter surrounding the confined space incident to determine the presence of or potential for a hazardous condition that could pose a risk to rescuers during approach
(2) Recognition of the need for decontamination of a patient or responder who might have been exposed to a hazardous material as per NFPA 471, *Recommended Practice for Responding to Hazardous Materials*

Incidents; NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*; and OSHA regulations in 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER)

(3) Recognition of the need for a confined space rescue service or additional resources when nonentry retrieval is not possible

(4) Notification of the designated rescue service and other resources necessary for initiation of confined space rescue

(5) Recognition of hazardous atmospheres or materials through visual assessment and information received from on-site personnel

A.7.2.4(4) The term *confined space* as defined within this standard is synonymous with the term *permit-required confined space* or *permit space* used by many U.S. federally regulated agencies.

A.7.2.4(5) Retrieval includes the operation of common nonentry retrieval systems. Examples include simple winch and block devices used in conjunction with tripods, quadpods, or other manufactured portable anchor systems. A nonentry retrieval can simply involve operating the crank on a winch/tripod system when anchors and protection systems are already in place.

A.7.2.4(6) The emergency response system includes, but is not limited to, operations- and technician-level organizations capable of responding to various types of search and rescue incidents, as well as local, state, and national resources. In addition, the system includes procurement of on-site information resources such as witnesses, industrial entry supervisors, industrial facility managers, engineers, or other responsible persons. Printed on-site information resources available at many U.S. federally regulated industrial facilities can include, but are not limited to, the following:

(1) Entry permit

(2) Material safety data sheets (MSDS)

(3) Other site work permits

A.7.2.4(7) These procedures should include the process of achieving and maintaining control of the site and the perimeter. This process might include management of all civilian and nonemergency personnel and establishment of operational zones and site security. The organization should also assure through written standard operating guidelines that the scene is rendered safe at the termination of the incident.

A.7.3.3(1) The assessment at this level should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Hazards such as engulfment potential, environmental hazards (e.g., chemical, atmospheric, temperature), harmful forms of energy (e.g., electrical, mechanical, movement due to gravity, hydraulic), configuration hazards (e.g., diverging walls, entrapment, obstructions, trip/fall hazards), and so forth
(2) Risk/benefit analysis (body recovery versus rescue)
(3) Available/necessary additional resources
(4) Establishment of control zones
(5) Magnitude of the hazard and isolation procedures
(6) Effectiveness of the nonentry or qualifying entry-type rescue
(7) Overall safety of rescue operations
(8) Level of rescue response (appropriate for the type of rescue being attempted)
(9) Current and projected status of the planned response
(10) Personnel accountability

A site safety plan can also provide useful information for consideration during size-up and should include the following:

(1) Rescue team notification
(2) Acceptable entry conditions for rescue
(3) Hazard identification
(4) Risk assessment of hazards
(5) Site map
(6) Hazard abatement (including control zones, ventilation, and lockout/tagout procedures)
(7) Use of buddy system (where applicable)
(8) Communications (e.g., site, rescue attendant to rescue entrant)
(9) Command post
(10) Incident management organizational chart
(11) Standard operating guidelines
(12) Safe work practices
(13) Medical assistance
(14) Pre-entry safety briefings
(15) Pre- and post-entry physicals (if indicated)

A.7.3.3(2) See Annex H.

A.7.3.3(3) The AHJ should address the possibility of members of the organization having physical and/or psychological disorders (e.g., physical disabilities, fear of heights, fear of enclosed spaces) that could impair their ability to perform rescue in confined spaces.

A.7.3.3(4) Roles, functions, and responsibilities for these team positions should be consistent with the organization's standard operating guidelines for confined space rescue.

A.7.3.3(5) Personnel meeting the requirements of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, should perform the monitoring procedures even if such personnel are not part of the rescue team. Monitoring the atmosphere can include the following considerations:

(1) Acceptable limits for oxygen concentration in air should be between 19.5 percent and 23.5 percent. An oxygen-enriched atmosphere is considered to be greater than 23.5 percent and poses a flammability hazard. An oxygen-deficient atmosphere is considered to be lower than 19.5 percent and can lead to asphyxiation without fresh-air breathing apparatus.
(2) Flammability is measured as a percentage of a material's lower explosive limit (LEL) or lower flammable limit (LFL). Rescuers should not enter confined spaces containing atmospheres greater than 10 percent of a material's LEL regardless of the personal protective equipment worn. There is no adequate protection for an explosion within a confined space.

(3) Acceptable toxicity levels are specific to the hazardous material involved, and chemical properties should be assessed to determine the level of the hazard for a given environment and time frame.

The confined space rescue team at the operations level should have available resources capable of understanding the assessment tools necessary for analysis and identification of hazardous conditions within confined spaces and interpretation of that data. This capability should include at least the following:

(1) Identification of the hazards found within confined spaces and understanding how those hazards influence victim viability and rescue/recovery operations

(2) Selection and use of monitoring equipment to assess the following hazards:
   (a) Oxygen-deficient atmospheres
   (b) Oxygen-enriched atmospheres
   (c) Flammable environments
   (d) Toxic exposures
   (e) Radioactive exposures
   (f) Corrosive exposures

(3) Understanding of the limiting factors associated with the selection and use of the atmospheric and chemical monitoring equipment provided by the AHJ for confined space emergencies. This equipment could include, but is not limited to, the following:
   (a) Calorimetric tubes
   (b) Oxygen concentration monitor (continuous reading, remote sampling)
   (c) Combustible gas monitor (continuous reading, remote sampling)
   (d) Specific toxicity monitor (continuous reading, remote sampling)
   (e) Multigas atmospheric monitors (continuous reading, remote sampling)
   (f) Passive dosimeter
   (g) pH papers, pH meters, and pH strips
   (h) Radiation detection instruments

   The factors determined by this equipment include, but are not limited to, calibration, proper operation, response time, detection range, relative response, sensitivity, selectivity, inherent safety, environmental conditions, and the nature of the hazard.

(4) Utilization and evaluation of reference terms and resources to include, but not be limited to, the following:
   (a) Lethal concentration-50 (LC-50)
   (b) Lethal dose-50 (LD-50)
   (c) Permissible exposure limit (PEL)
   (d) Threshold limit value (TLV)
   (e) Threshold limit value—short-term exposure limit (TLV-STEL)
   (f) Threshold limit value—time-weighted average (TLV-TWA)
   (g) Immediately dangerous to life and health (IDLH)
   (h) MSDS
   (i) Reference manuals
   (j) Computerized reference databases
   (k) Technical information centers
   (l) Technical information specialists
   (m) Monitoring equipment

A.7.3.3(6) The intent of this item is to restrict entries made by operations-level organizations to those that would absolutely minimize risk to rescue entrants. It is the intent of this document that operations-level teams not perform hazardous entries.

A.7.3.3(6)(a) The intention of this item is to limit the danger of entanglement.

A.7.3.3(6)(b) The intention of this item is to ensure that the attendant can maintain direct observation of the entrants at all times, making recognition of problems more rapid.

A.7.3.3(6)(c) The intention of this item is to allow for easier retrieval of rescue entrants should this become necessary and to provide for passage through the opening without removal of necessary personal protective equipment, including fresh-air breathing apparatus.

A.7.3.3(6)(d) The intention of this item is to allow a "buddy system" to be employed, providing potentially faster response to a problem with one of the rescue entrants.

A.7.3.3(6)(e) The intention of this item is to ensure that hazards to rescuers in organizations at this level are kept to an absolute minimum.

A.7.3.3(7) Packaging devices that can be used in confined spaces include, but are not limited to, the following:

(1) Full spine immobilization devices
(2) Short spine immobilization devices
(3) Cervical spine immobilization devices
(4) Litters
(5) Prefabricated full-body harnesses
(6) Tied full-body harnesses
(7) Wrist loops (wristlets)

A.7.3.3(9) See Annex I.

A.7.3.3(10) Organizations at the operations level are expected to safely apply lowering and raising systems (rope or nonrope based) as appropriate during confined space emergencies. These applications can involve the use of rope rescue systems in the high-angle environment to both lower rescuers into and remove rescuers and victims from confined spaces. The determination of what systems are most appropriate to accomplish these tasks should be dictated by the circumstances surrounding the incident.

A.7.4.2 While six people provide the recommended minimum for most entry-type confined space rescues, some such rescues will require fewer. The number of personnel required should be determined by the situation, hazards, and degree of difficulty of the situation confronted.

A team is "qualified" by its capability as a team, not by the individual qualifications of its members.

A.7.4.3(1) The size-up/assessment at this level should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Available and necessary additional resources
(2) Hazard isolation and control requirements

A.7.4.3(2) Procedures should be consistent with local, state, and federal guidelines such as those found in 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER).

A.7.4.3(3) Planning response for entry-type rescues with hazards should consider the following issues:

(1) Options for entry-type confined space rescues beyond the capability of operations-level personnel
(2) Selection, use, and maintenance of, as well as training relative to, personal protective clothing and equipment provided by the AHJ for operating in and around confined space emergencies
(3) Determination of response objectives based on circumstances of the confined space emergency. The response objective can involve any one of the following:
    (a) Victim rescue
    (b) Victim recovery
    (c) Remote extrication
    (d) Nonintervention
(4) Verification of the need for emergency decontamination
(5) Development of a plan of action, including safety considerations, consistent with the organization's standard operating guidelines, for entry-type confined space rescue. Components of a typical action plan might include the following:
    (a) Site assessment

(b) Confined space assessment
(c) Resource organization and accountability [incident management system (IMS)]
(d) Perimeters and control zones
(e) Hazard evaluation
(f) A comprehensive risk/benefit analysis that evaluates the viability of the victim
(g) Personal protective equipment
(h) Chemical protective clothing
(i) Specialized rescue equipment
(j) Rescue/recovery objectives
(k) On-scene work assignments
(l) Communications procedures
(m) Emergency decontamination procedures (victim)
(n) Decontamination procedures (rescuers)
(o) On-scene safety and health procedures including personnel health monitoring, on-scene rehabilitation, emergency medical care procedures, and the designation of a safety officer
(p) Scene termination procedures

(6) Implementation of the planned response to successfully rescue or recover victims from confined spaces by completing the following tasks:
(a) Perform the duties of an assigned position within the local IMS
(b) Perform entry-type rescues from confined spaces
(c) Perform support functions for entry-type rescues from confined spaces
(d) Don, safely operate, and doff appropriate personal protective clothing including, but not limited to, liquid splash protection and vapor protective clothing, which might be required when operating around the scene of confined space emergencies involving hazardous materials

(7) Development of procedures that include required equipment and safety precautions for the following entry-type confined space rescues:
(a) Vertical rescue
(b) Horizontal rescue
(c) Suspended victim rescue
(d) Entrapped or engulfed victim (collapse, particulate matter, etc.)

A.7.4.3(4) See A.7.4.3(3).

A.8.1 It is the intent of this provision that the AHJ, as part of the hazard identification and risk assessment, identify the types of vehicles and machinery within its response area. These types can include, but are not limited to, cars, trucks, buses, trains, mass transit systems, aircraft, watercraft, agriculture implements, industrial/construction machinery, and elevators/escalators. The AHJ should develop procedures and provide training to personnel that is commensurate with the potential for search and rescue situations involving the above-mentioned vehicles and machinery.

A.8.2.3(2) See A.4.2.5.

A.8.2.3(3) The emergency response system includes, but is not limited to, operations- and technician-level organizations capable of responding to various types of search and rescue incidents, as well as local, state, and national resources.

A.8.2.3(4) These procedures should include the process of achieving and maintaining control of the site and the perimeter. They might include management of all civilian and nonemergency personnel and establishment of operational zones and site security.

A.8.2.3(5) General hazards associated with operations at vehicle and machinery search and rescue incidents can present the AHJ with uniquely challenging situations. The AHJ should consider the following potential hazards when providing training to its members.

(1) *Utilities.* Control of the utilities in and around a vehicle or machinery search and rescue incident is critical to ensure the safety of responding personnel and victims. The AHJ should provide its members with training in

the control of these services to provide a safe environment in which to operate and to ensure the safety of victims. The following utilities should be considered when providing training:

(a) Electrical services (primary and secondary)
(b) Gas, propane, fuel oil, or other alternative energy sources (primary systems)
(c) Water
(d) Sanitary systems
(e) Communications
(f) Secondary service systems (such as compressed, medical, or industrial gases)

(2) *Hazardous Materials.* Vehicle and machinery rescue incidents might include various materials that, when released during an incident, could pose a hazard to victims and responders. The AHJ should provide members with training in the recognition of potential hazardous material releases, the determination of an existing hazard, and the methods used to contain, confine, or divert hazardous materials to conduct operations safely and effectively.

(3) *Personal Hazards.* At the site of any vehicle and machinery search and rescue incident, there are many dangers that pose personal injury hazards to the responders. The AHJ should train members to recognize the personal hazards they encounter and to use the methods needed to mitigate these hazards to help ensure their safety. Every member should be made aware of hazards such as trips, falls, blows, cuts, abrasions, punctures, impalement, and so forth.

(4) *Movement of Vehicle(s) and Machinery.* Uncontrolled movement of vehicle(s) and machinery components can cause extremely hazardous and potentially fatal situations. Responding personnel should be familiar with and trained in techniques for stabilizing and removing the potential for movement of vehicle(s) and machinery components.

(5) *Release of High-Pressure Systems.* Vehicles and machinery often include high-pressure systems (e.g., hydraulic, pneumatic) that can fail without warning. Such failure can cause extremely hazardous conditions, injury, and death of victims and responders. The AHJ should provide members with training in the recognition of potential high-pressure system hazards, the determination of an existing hazard, and the methods used to contain, confine, or divert such hazards to conduct operations safely and effectively.

(6) *Other Hazards.* There are numerous other hazards associated with vehicle and machinery search and rescue incidents. The AHJ should make every effort to identify the hazards that might be encountered within the jurisdiction and should provide members with training and awareness of these other hazards to allow them to perform search and rescue operations safely and effectively.

A.8.3.4(1) The size-up should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Scope and magnitude of the incident
(2) Risk/benefit analysis (body recovery versus rescue)
(3) Number and size of vehicles or machines affected
(4) Integrity and stability of vehicles or machines affected
(5) Number of known or potential victims
(6) Access to the scene
(7) Hazards such as disrupted or exposed utilities, standing or flowing water, mechanical hazards, hazardous materials, electrical hazards, and explosives
(8) Exposure to traffic
(9) Environmental factors
(10) Available versus necessary resources

A.8.3.4(3) The search and rescue area is that area immediately surrounding [within a 6.10 m (20 ft), or so, radius of] the vehicle or machinery. Making the search and rescue area safe includes, but is not limited to, the following actions; however, specific actions should be based on the vehicle or machinery type and specific situation:

(1) Establishing operational zones (i.e., hot, warm, cold) and site security

(2) Utilizing specific techniques and tools (including cribbing, chocks, and wedges) to stabilize the vehicle
(3) Utilizing specific techniques and tools (i.e., lockout and tagout) to isolate the involved equipment
(4) Making the search and rescue area (i.e., hot zone) safe for entry
(5) Safely undertaking disentanglement and extrication operations using hand tools
(6) Ventilating the search and rescue area and monitoring its atmosphere when necessary
(7) Supporting any unbroken utilities
(8) Providing protective equipment for any victims, if possible, when necessary
(9) Prohibiting entry into an unsafe vehicle or machinery search and rescue area
(10) Preventing the touching or operating of equipment or machinery involved until its safety has been established

A.8.3.4(8) To ensure a safe disentanglement or extrication operation, the AHJ should provide training on the following topics:

(1) Types of passenger restraint systems
(2) Frame and construction features of vehicles
(3) Types of suspension systems in vehicles
(4) Types and classification of impacts
(5) Categories of mechanical injury
(6) Various stabilization techniques
(7) Center of gravity and its relationship to rollover
(8) Use of cribbing and chocks
(9) Building a crib box
(10) Types and examples of levers for mechanical advantage
(11) Proper and effective use of hand tools including a hammer, pry bar, hacksaw, glass punch, Halligan, knife or belt cutter, cable cutter, and come-along
(12) Disentanglement through primary access points
(13) Patient packaging prior to removal from a vehicle or machine
(14) Protection of the victim during extrication or disentanglement operations
(15) Proper and effective use of power tools such as hydraulic, pneumatic, and electrical spreading, cutting, lifting, and ram-type tools

A.8.3.4(9) These procedures refer to the mitigation and management of the hazards identified in A.8.2.3(5).

A.8.4.2(2) To ensure that disentanglement or extrication from large, heavy vehicles or machines is performed safely, the AHJ should provide training on the following topics:

(1) Frame and construction features of heavy, large vehicles and machinery
(2) Use and components of a search and rescue chain assembly
(3) Pneumatic high-, medium-, and low-pressure lifting bags
(4) Use, care, and maintenance of wire rope and its associated equipment
(5) Large and heavy object weight estimation
(6) Steps necessary to lift or move large objects
(7) Use of cribbing and chocks with large and heavy objects
(8) Use of commercial heavy wreckers and recovery services to assist at incidents involving large transportation vehicles
(9) Use, care, and maintenance of both manual and power winches
(10) Types and examples of lifting devices that use mechanical advantage principles
(11) Proper and effective use of power tools including hydraulic, pneumatic, and electrical spreading, cutting, lifting, and ram-type tools
(12) Disentanglement through both primary and secondary access points through the use of available power tools
(13) Protection of the victim during this type of extrication or disentanglement operation

(14) Lockout/tagout of machinery
(15) Identification and use of various sling configurations

A.8.4.2(3) "Unusual" situations include, but are not limited to, extrication or disentanglement operations at incidents involving cars on their tops, cars on their sides, and cars on top of other cars, trucks, and large commercial vehicles.

"Advanced stabilization" includes techniques using chains, cables, jack devices, and cribbing or shoring to stabilize vehicles of any size.

A.8.4.2(4) Power tools (e.g., air bags, hydraulic spreaders and rams, hand tools, and other power tools) and training necessary to remove, cut, and move components displaced at a vehicle or machinery search and rescue incident should be provided. "Specialized rescue equipment" can include, but is not limited to, hydraulic, pneumatic, and electrical spreading, cutting, lifting, and ram-type tools immediately available and in use by the organization.

A.9.2.3(2) The assessment phase includes an evaluation of the subject's condition and the subject's ability to assist in his or her own rescue. Consideration should be given to the need for dive rescue early in the assessment phase. The best intended surface rescue could eventually require dive capability.

A.9.2.3(3) See A.4.2.5.

A.9.2.3(4) The emergency response system includes, but is not limited to, operations- and technician-level organizations capable of responding to various types of search and rescue incidents, as well as local, state, and national resources.

A.9.2.3(5) These procedures should include the process of achieving and maintaining control of the site and the perimeter. This might include management of all civilian and nonemergency personnel and establishment of operational zones and site security.

A.9.2.3(6) General hazards associated with water search and rescue operations can present the AHJ with uniquely challenging situations. The AHJ should consider the following potential hazards when providing training to its members.

(1) *Utilities.* Control of the utilities in and around a water incident is critical to ensure the safety of responding personnel and victims. The AHJ should provide its members with training in the control of these services to provide a safe environment for them to operate in and to ensure the safety of victims. The following utilities should be considered when providing training:
   (a) Electrical services (primary and secondary)
   (b) Gas, propane, fuel oil, or other alternative energy sources (primary systems)
   (c) Water/steam
   (d) Sanitary systems
   (e) Communications
   (f) Secondary service systems (such as compressed, medical, or industrial gases)

(2) *Hazardous Materials.* Water incident sites might include various materials unique to a site that, when released during a search and rescue operation, could pose a hazard to victims and responders. The AHJ should provide its members with training in the recognition of potential hazardous material releases, the determination of an existing hazard, and the methods used to contain, confine, or divert hazardous materials to conduct operations safely and effectively.

(3) *Personal Hazards.* At the site of any water incident, there are many dangers that pose personal injury hazards to the responders. The AHJ should train its members to recognize the personal hazards they encounter and to use the methods needed to mitigate these hazards to help ensure members' safety. Every member should be made aware of hazards such as trips, falls, blows, punctures, impalement, and so forth.

(4) *Confined Space.* Some water incident sites necessitate a confined space rescue. Responding personnel should be familiar with and trained in confined space rescue requirements and techniques. The AHJ should determine the applicable laws and standards related to confined space rescue and should provide training to its members in confined space rescue.

(5) *Hazards That Are Immediately Dangerous to Life and Health.* These hazards include swift water with currents exceeding those in which a person or watercraft can safely and effectively operate.

(6) *Other Hazards.* There are numerous other hazards associated with water search and rescue operations. The AHJ should make every effort to identify the hazards that might be encountered within the jurisdiction and should provide its members with training and awareness of these other hazards to allow them to perform search and rescue operations safely and effectively.

(7) *General Area.* The general area around a water incident site is the entire area around a search and rescue site. Any member operating within the vicinity of the water's edge can accidentally enter the hazard zone. PPE should be utilized accordingly. Making the general area safe includes, but is not necessarily limited to, the following:

(a) Controlling/limiting access to the area by unnecessary personnel
(b) Identifying hazards and removing or reducing their impact
(c) Utilizing personal flotation devices (PFDs) and other PPE

A.9.3.3 Certain jurisdictions might not need to achieve operational capability in one or more specialties. The organization should have the option of selecting those specialties relevant to needs identified in the risk assessment and hazard identification.

A.9.3.4 Further requirements of PPE are included in 4.4.2 of this standard. This requirement applies to all the described disciplines.

A.9.3.4(3) It is important to note that fire-related PPE such as fire helmets and boots are not typically appropriate for water rescue work and in some cases actually pose a hazard.

A.9.3.5(1) The size-up should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Scope, magnitude, and nature of the incident
(2) Location and number of victims
(3) Risk/benefit analysis
(4) Separation, isolation, security, and interviewing of witnesses
(5) Hazards such as disrupted or exposed utilities, standing or flowing water, mechanical hazards, hazmat, and explosives
(6) Access to the scene
(7) Environmental factors
(8) Resource assessment, internal and external
(9) Rescue verses recovery

A.9.3.5(2) These procedures include, but are not limited to, ensuring the wearing of proper PPE, procedural checklists, site security (keeping bystanders back), reviewing the operational plan (and one's place in the plan), reviewing communications procedures (rescuer to tender, tender to shore, rescuer to rescuer), reviewing emergency procedures, proper attire for the potential weather, reviewing procedures for equipment handling, and ensuring proper rest and attitude for the operation. Water rescue requires a combination of knowledge, skills, abilities, physical fitness, and judgment to expect positive outcomes. These things are to be gained through a combination of training and experience.

A.9.3.5(3) Hazards to both victim and rescuer include, but are not limited to, the following:

(1) Holes
(2) Strainers
(3) Hydraulics
(4) Low head dams
(5) Debris
(6) Cold water
(7) Currents
(8) Undercuts
(9) Backwash
(10) Outwash
(11) Contamination
(12) Obstructions

(13) Turbidity

A.9.3.5(5) Mechanisms of entrapment include, but are not limited to, the following:

(1) Undercuts
(2) Underwater hazards
(3) Strainers
(4) Hydraulics

A.9.3.5(6) It is important for the organization to have the capability to continuously evaluate the effectiveness of the chosen plan of action. If the initial plan is not working, or requires modification to ensure safety or effectiveness, the plan should be changed. The potential for "tunnel vision" (a narrow focus excluding important influences) should be considered by those running the operation.

A.9.3.5(7) Shore-based rescues include, but are not limited to, reaching to a victim, throwing something to a victim (e.g., rope, buoy), and talking a victim into self-rescue. Many readily available items found on shore can be used to reach to a victim in the water while not exposing the rescuer to undue risk. Important aspects of reaching techniques include body position and reaching device selection (i.e., anything that can be used to extend a rescuer's reach). Many items (e.g., throw bag, PFD, ring buoy, manufactured flotation or rope-throwing devices) found on shore can be thrown to a victim and used either as flotation or to pull the victim to shore.

A.9.3.5(8) The accurate use of throw bags takes practice and knowledge of proper body position, throwing technique, rope retrieval technique, and target selection (e.g., upstream in moving water, slightly beyond the victim).

A.9.3.5(9) Members of organizations at the operations level should have the ability to assist other rescue personnel with the construction of rope rescue systems. Skills involved in supplying this assistance include, but are not limited to, equipment identification, knot-tying capability, and limited knowledge of how the applicable rope rescue equipment should be used.

A.9.3.5(11) Procedures for survival swimming and self-rescue are important because a rescuer might find himself or herself unintentionally in the water. These procedures should include, but are not limited to, the ability to float and swim with and without flotation, the ability to conserve body heat while immersed in water (heat escape lessening position), the ability to use one's clothing for flotation, and the ability to remove one's self from the water by climbing into a boat, exiting at shore, or exiting from a pool's edge.

A.9.3.5(12) Environmental conditions like weather and temperature play an important role in a rescuer's safety and comfort. Cold temperatures can lead to hypothermia and/or local cold injuries that can seriously impair a rescuer's ability to think and act. Wetness, through perspiration or from the environment, can substantially increase the speed at which a rescuer becomes affected by cold. Therefore, thermal protection from the elements is essential for safe operations in cold and wet environments.

It is also very important to note that all environments can lead to heat stress as well. For example, much of the apparel designed for rescue operations serves to protect the rescuer from heat loss and wet by being waterproof and insulating its wearer from the ambient environment. Unfortunately, a side effect of such garments is the serious impairment of the body's most effective means of thermal regulation: the evaporation of perspiration from the skin. In all environments and conditions, rescuers wearing proper PPE will require great attention to the substantial potential for thermal stress (e.g., overheating). Pre-operation physical exams, appropriate hydration/ nutrition, and monitored rehabilitation are essential for safe operations and healthy personnel.

A.9.3.5(14) The regular use of an approved form for the collection and transfer of this information is recommended.

A.9.3.5(15) Boat-based operations include, but are not limited to, the capability to perform surface support operations from within a boat while in surf, on the water, or on ice (whichever is applicable).

A.9.3.5(17) Accessible victims are those who can be retrieved without the rescuer having to venture out onto the ice or into the water.

A.9.3.6(1) Hazards associated with dive operations include, but are not limited to, the following:

(1) Barotraumas (decompression sickness, nitrogen narcosis, oxygen toxicity, etc.)
(2) Drowning
(3) Hyperventilation, hypercarbia, and other respiratory problems

(4) Anxiety reactions
(5) Fatigue and exhaustion
(6) Dehydration (electrolyte imbalances)
(7) Heat stress (i.e., heat exhaustion, stroke, and cramps)
(8) The combination of prescription medication or smoking and diving
(9) Pre-existing medical conditions or injuries
(10) Hypothermia

A.9.3.6(2) Support personnel are called upon to assist technicians in preparing to dive, dress, and equip divers; provide search pattern control and direction; monitor divers' time, depth, dive profile, and air supply; and provide a communication link to the surface via electronic communication equipment or manual rope pull signals.

A.9.3.6(4) Surface support personnel should be capable of recognizing, maintaining, and operating all surface support equipment used by the organization.

A.9.3.6(7) Unusual or extreme environmental conditions can require very specialized dive and/or surface support training specific to the situation(s) encountered. *(See A.9.4.6.1 for some specialty examples.)*

A.9.3.7(1) Hazards associated with ice rescue include, but are not limited to, the following:
(1) Hypothermia
(2) Localized cold injuries (i.e., frostbite, frostnip)
(3) Thermal burns from heating devices

A.9.3.7(2) Rescuers should be able to recognize and describe the implication of the following ice and water characteristics:
(1) New (frazil) ice
(2) Candle ice
(3) Old (rotten) ice
(4) Clear (hard) ice
(5) Milk ice
(6) The depth of ice and how it relates to carrying capacity
(7) Water currents and how they relate to ice thickness
(8) Obstacles and how they relate to current and ice formation
(9) Salt water and ice formation (i.e., sea ice)

A.9.3.7(3) Surface support personnel should be capable of recognizing, maintaining, and operating all surface support equipment used by the organization.

A.9.3.7(5) One component of hypothermia that should be emphasized to cold weather rescuers is the effects of cold weather/water on a victim's ability to help himself or herself respond to instructions from rescuers or assist in his or her rescue.

A.9.3.8(1) Surf hazards include, but are not limited to, the following:
(1) Riptides
(2) Undertows
(3) Currents
(4) Tides
(5) Obstructions
(6) Debris
(7) Cold water
(8) Contamination

A.9.3.8(4) See A.9.3.5(9).

A.9.3.9.2(1) The ability to assess moving water is important for safe operations. Examples of water characteristics and features that should be identifiable include eddies, downstream/upstream “V”s, standing waves, laminar/helical flows, confluence, cushion/pillows, and swift-water classifications.

A.9.3.9.2(3) A tag line is a line stretched across a river and brought to the level of a stationary victim. A floating tag line has a flotation device attached to the line to keep the rope on the surface of the water and to provide something for the victim to grasp. A snag line is a variation of the tag line that is weighted to reach an object beneath the surface of the water. A tension diagonal, or zip line, is a line positioned at an angle greater than 45 degrees diagonal to the water's flow and just above the surface of moving water, anchored at both ends and tensioned tightly. This type of taut, diagonal line can be used in a variety of ways as an operational rescue tool.

A.9.3.9.2(4) Swift water self-rescue involves all capabilities discussed in A.9.3.5(9) as well as the capability to swim in current while defending against obstacles that are likely to be encountered.

A common technique used to swim safely in moving water is to swim face up with the feet downstream while using the hands to maneuver (swim). When obstacles such as rocks are encountered the feet can be used to push off. If strainers are encountered that cannot be circumnavigated, the swimmer should make every attempt to swim over (never under or through) them while maneuvering toward a safe shore. Additional hazards can be found in A.9.3.5(3).

A.9.4.5(4) Boat-assisted operations involve the actual performance of rescue techniques through the use of one or more boats. *[See also A.9.3.5(15).]*

A.9.4.5(5) "Go" techniques include, but are not limited to, the following:

(1) Shallow water crossing
(2) In-water contact rescues with or without floating rescue devices, including rescue tubes, boards, and so forth
(3) Rescuer combat techniques (i.e., blocks/escapes) when in-water contact rescues are conducted
(4) The use of specialized PPE (i.e., rescue release personal flotation devices) and other specialized equipment and techniques utilized by the AHJ
(5) Advanced rope rescue techniques, including the use of high lines
(6) Other "go" techniques and more advanced options utilized by the AHJ

A.9.4.6.1 Examples of specialty dive training include the following:

(1) Dry suit use
(2) Full face or light helmet use
(3) Underwater communications equipment
(4) Deep diving
(5) Night/limited visibility, current, polluted water
(6) Team operations, leadership
(7) Lifting equipment
(8) Cave/cavern diving
(9) Tidal diving, surface supply diving
(10) Ice diving
(11) Underwater tools

Organizations at the technician level can gain knowledge, skills, and abilities necessary to extend their capabilities at a controlled training situation.

Additional areas that might need to be addressed include the following:

(1) Scene surveys
(2) Drowning accidents
(3) Operational planning
(4) Effective search patterns
(5) Electronic equipment (e.g., sonar, underwater video)
(6) Safety procedures
(7) Handling of outside influences
(8) Rescue/recovery techniques and procedures
(9) Incident management system (IMS)
(10) Critical incident stress debriefing (CISD)

(11) Risk/benefit analysis

A.9.4.6.1.1 Nationally recognized agencies include, but are not limited to, the following:

(1) PADI (Professional Association of Dive Instructors)
(2) SSI (SCUBA Schools International)
(3) NAUI (National Association of Underwater Instructors)
(4) YMCA (Young Men's Christian Association)
(5) PDIC (Professional Diving Instructor's Corporation)
(6) DRI (Dive Rescue International)
(7) NASDS (National Association of SCUBA Diving Schools)
(8) MDEA (Multinational Diving Educators Association)
(9) IDEA (International Diving Educators Association)
(10) LACUI (Los Angeles County Underwater Instructors)

A.9.4.6.2 Fitness provides reserve capacity to deal with physical challenges that can occur during dive operations. Research indicates that the fitness evaluations specified in Figure A.9.4.6.2(a) and Figure A.9.4.6.2(b) provide a minimum aerobic capacity to SCUBA dive safely. Annual skill evaluations help ensure diver competence relative to fundamental survival skills. Many investigators, researchers, and authors support the belief that poor SCUBA skills are a direct or indirect cause of diver fatalities.

I.A.D.R.S. Annual Watermanship Test / Skills Test

Annual Watermanship Evaluation Parameters

There are four exercises that evaluate stamina and comfort in the water, each rated by points. The diver must successfully complete all stations and score a minimum of 12 points to pass the test.

Stamina Exercise 1: **500 yard Swim**

The diver must swim 500 yards without stopping using a forward stroke and without using any swim aids such as dive mask, swim goggles, fins, snorkel, or flotation device. Stopping or standing up in the shallow end of the pool at any point during this exercise will constitute a failure of this evaluation station.

Time To Complete	Points Awarded
Under 10 minutes	5
10 to 13 minutes	4
13 to 16 minutes	3
16 to 19 minutes	2
More than 19 minutes	1
Stopped or incomplete	Incomplete

Stamina Exercise 2: **15 Minute Tread**

Using no swim aids and wearing only a swimsuit, the diver will stay afloat by treading water, drown-proofing, bobbing, or floating for 15 minutes, with hands only out of the water for the last 2 minutes.

Performance Criteria	Points Awarded
Performed satisfactorily	5
Stayed afloat, hands not out of water for 2 minutes	3
Used side or bottom for support at any time	1
Used side or bottom for support > twice	Incomplete

Stamina Exercise 3: **800 yard Snorkel Swim**

Using a dive mask, fins, snorkel, and swimsuit (no BCD or other flotation aid) and swimming the entire time with the face in the water, the diver must swim nonstop for 800 yards. The diver must not use arms to swim at any time.

Performance Criteria	Points Awarded
Under 15 minutes	5
15 to 17 minutes	4
17 to 19 minutes	3
19 to 21 minutes	2
More than 21 minutes	1
Stopped at any time	Incomplete

Stamina Exercise 4: **100 yard Inert Diver Rescue Tow**

Wearing full scuba equipment and breathing air, the diver must push or tow an inert diver wearing dive gear on the surface 100 yards nonstop without assistance.

Performance Criteria	Points Awarded
Under 2 minutes	5
2 to 3 minutes	4
3 to 4 minutes	3
4 to 5 minutes	2
More than 5 minutes	1
Stopped at any time:	Incomplete

Additional copies available at no charge via the International Association of Dive Rescue Specialists webpage. Visit www.IADRS.org

FIGURE A.9.4.6.2(a) Watermanship/Skills Test.

I.A.D.R.S. Annual Basic Scuba Skills Evaluation

Diver's Name: _____ Department: _____

Air Consumption: Start _____ psi / Finish _____ psi Time: Start _____ / Finish _____ / Total _____

Water Depth: _____ Pool / Open Water (circle one) Examiner: _____

Task grading: S = Satisfactory N = Needs Improvement (specify) N/A = Not Applicable (use for equipment only)

Equipment Handling and Set-Up

_____ - properly assembles equipment (basic gear / specialty gear)
_____ - shows familiarity and comfort with equipment
_____ - properly protects equipment (i.e. tank valve / regulator)
_____ - review (line & hand signals / air consumption rates / buddy awareness / emergencies / diver log)

Watermanship Skills

_____ - 500 yard continuous forward stroke swim - no swim aids for time (refer to grading criteria)
_____ - 15 minute tread / last 2 minutes with hands out of water (refer to grading criteria)
_____ - 800 yard snorkel swim (refer to grading criteria)
_____ - 100 yard inert diver rescue tow (refer to grading criteria)

Skin Diving Skills

_____ - mask clearing
_____ - snorkel clearing (popping & expansion)
_____ - snorkel without mask (led by partner, 1 lap)
_____ - fin kicks (flutter / dolphin) one length each, using mask and snorkel
_____ - in-water surface dives (head first / feet first)

SCUBA Diving Skills

_____ - entries (giant stride / seated or controlled entry)
_____ - neutral buoyancy control (oral / power) inflation
_____ - dry suit buoyancy control and emergency procedures (i.e., hose disconnect or flooding)
_____ - regulator clearing (blowing / purging) and retrieval
_____ - regulator without mask (led by partner, 1 lap)
_____ - full face mask (removal / switch to regulator / clearing full face mask / replace full face mask)
_____ - descent procedures (signal / check time & air / raise inflator hose / feet first descent / clear ears)
_____ - ascent procedures (signal / check time & depth / + buoyancy / raise inflator hose / ascend @ 20 ft/min)
_____ - air sharing at depth and during ascent
_____ - buddy breathing at depth and during ascent
_____ - emergency swimming ascent procedures (simulate out of air / signals / ascends / continuous exhaling / surfaces / inflates BC orally using bobbing technique)
_____ - emergency buoyant ascent procedures (simulate out of air / signals / drops weights / ascends / continuous exhaling / surfaces / inflates BC orally using bobbing technique)
_____ - weight belt (removal / replacement) on surface and bottom
_____ - buoyancy control device (removal / replacement) on surface and bottom
_____ - OPTIONS: Blackout Mask / Night Dive / Navigation / Confidence Obstacle Course

Performance Comments: _____

_____

Equipment Care and Storage

_____ - properly disassembles equipment
_____ - cleans and restores equipment properly

Additional copies available at no charge via the International Association of Dive Rescue Specialists webpage. Visit www.IADRS.org

FIGURE A.9.4.6.2(b) Basic SCUBA Skills Evaluation.

A.9.4.6.3(1) Training in skin and SCUBA diving should include, but not be limited to, the information conveyed in a nationally recognized skin/SCUBA diving program.

A.9.4.6.3(3) Safe use of dive tables means precise use of nationally recognized dive tables specified for the type of dive operation undertaken.

A.9.4.6.3(8) The treatment of dive-related injuries and maladies is often beyond the capability of standard basic life support (BLS) providers. Therefore, the AHJ should ensure that procedures are in place during any dive to provide appropriate emergency medical care for the treatment of dive-related injuries. This preparation can include the training of selected personnel as dive medics (a specialized emergency medical training program) or establishing a standard operating procedure (SOP) to address the situation.

Many investigators, researchers, and authors support the theory that psychological and physiological problems are a direct or indirect cause of most diver fatalities. Stress leading to panic may be the largest single factor in divers lost. Dive organizations should conduct training and operations to address these factors and to minimize their negative effects.

A.9.4.6.3(10) The use of a full-face mask with electronic communication provides for the ability for surface support personnel to continuously monitor both a diver's comfort and physiological state. The preferred method is full duplex (simultaneous bidirectional communication) to allow the respirations and comfort of the diver to be monitored continuously and is vital to ensuring the diver's safety. Commercial and naval divers define minimum equipment as helmet or full-face mask with communication to the surface with a trained tender as vital to diver safety. It is not trivial that their safety record far exceeds that of the current public safety diving community.

A.9.4.6.3(11) A diver running out of air for any reason is an immediately life-threatening event. Safe and effective techniques addressing this possibility are vital to the survival of public safety divers.

A.9.4.6.3(12) Public safety divers are exposed to a growing list of known and unknown chemical and biological contaminants. Exposure prevention is the best way to avoid potential problems. Examples of chemical exposures include those secondary to submerged vehicles, industrial chemicals, sewage runoff, and so on. Examples of biological hazards include *Pfiesteria dinoflagellates*, *Nigeria ameba*, and fecal coliforms.

A.9.4.6.3(13) The death of a public safety diver is often associated with entanglement. Safe and effective procedures to rescue entangled divers are vital to operations and necessary to improve the overall safety of public safety diving.

A.9.4.6.3(14) See NFPA 471, *Recommended Practice for Responding to Hazardous Materials Incidents*, Chapter 10, Medical Monitoring, for pre-entry and postentry monitoring.

An abbreviated exam in rescue mode can consist of oral history only (e.g., level of consciousness, recent illness, injury, or medication; recent alcohol ingestion; problems incompatible with equalizing). This exam can be accomplished as the diver is dressing.

A.9.4.6.3(15) Many public safety dive teams assist or provide evidence work as part of their mission. These skills must be performed correctly for a complete and successful outcome.

A.9.4.7(1) Capabilities necessary for self-rescue on ice include, but are not limited to, the following:

(1) Roll, crawl, or swim away from an ice hole
(2) Utilize any personal ice rescue equipment used by the organization such as ice awls, crampons, and so forth
(3) Practical methods of weight distribution

A.10.2.3(2) The emergency response system includes, but is not limited to, operations- and technician-level organizations capable of responding to various types of search and rescue incidents, as well as local, state, and national resources.

A.10.2.3(3) Training should address the process of achieving and maintaining control of the site and the perimeter. This control might include management of all civilian and nonemergency personnel and establishment of operational zones and site security.

A.10.2.3(4) General hazards associated with search and rescue operations in the wilderness can present the AHJ with uniquely challenging situations. The AHJ should consider the following potential hazards and, to help provide for their safety, ensure that members have the ability to recognize potential hazards that they can encounter.

(1) *Personal Hazards.* In the wilderness environment, there are many dangers that pose personal injury and physiological hazards to responders. Personnel should be made aware of hazards including, but not limited to, blisters, scrapes, scratches, falls, blows, bruises, dehydration, and so forth.
(2) *Environmental Hazards.* Depending on the specific environment, there are many dangers that pose hazards to responders. Personnel should be made aware of hazards including, but not limited to, insect bites and stings, poisonous plants, exposure injuries (cold and heat), snow blindness, altitude illness, lightning, sunburn, dangerous wildlife, and so forth.
(3) *Terrain Hazards.* Specific features in an environment can pose hazards to responders. Personnel should be made aware of hazards including, but not limited to, cliffs, avalanches, standing water (e.g., ponds, lakes), flat ice (e.g., ponds, lakes), moving water (e.g., rivers, streams), caves, mines, wells, high winds, snow (blowing and fallen), coastal white water surf, and so forth.
(4) *Man-Made Hazards.* Humans, whether intentionally or accidentally, can also cause unsafe conditions in the wilderness. Personnel should be made aware of hazards including, but not limited to, booby-trapped stills and labs (covert ethanol and drug production), hazardous materials dumps, trained attack dogs (protecting drug labs), and so forth.

A.10.2.3(6) Conventional emergency response PPE and equipment (especially fire-related equipment) is often inappropriate for use in a wilderness setting. For instance, fire helmets and boots can increase one's potential for injury in the wilderness. Conventional emergency response skills such as using a sphygmomanometer and using an ambulance cot have very little application in the wilderness. Therefore, such skills and equipment will require modification to achieve the rescuer's desired goals in the wilderness.

A.10.2.3(7) Documents for the collection and recording of information can include the following:
(1) Information regarding the lost person(s)
(2) Information needed to determine search urgency
(3) Information required by the AHJ
(4) Information required by the incident management system (IMS)
(5) Information required to identify a subject's track (i.e., footprint)
(6) Information for development of search strategy

A.10.2.3(8) Isolation includes keeping the reporting party handy for interviewers and isolated from media and the incident operations, as well as isolated from one another, in the case of multiple reporting parties.

A.10.3.2.1 In some cases, where minimum exposure to wilderness hazards exists, it can be appropriate for the AHJ to establish SOPs that permit an operations-level organization to conduct certain search and rescue operations without supervision of a technician-level organization.

A.10.3.3(1) The size-up should include, but not be limited to, the initial and continuous evaluation of the following:
(1) Scope and magnitude of the incident, including whether it is a search, rescue, or body recovery
(2) Assessment of time required
(3) Assessment of staffing needs
(4) Specific environmental factors involved
(5) Integrity and stability of the environment involved
(6) Number of known/potential victims
(7) Weather (current and forecast)
(8) Urgency (based on the type of known/potential victims)
(9) Available/necessary resources

A.10.3.3(2) Resources can include but are not limited to the following:
(1) Search dogs
(2) Trackers
(3) Aircraft
(4) Ground/air search specialists
(5) Rope rescue specialists
(6) Water search and rescue specialists

(7) Trench rescue specialists
(8) Vehicle/machinery rescue specialists
(9) Collapsed building search and/or rescue specialists
(10) Emergency incident management (overhead) teams
(11) Avalanche rescue specialists
(12) Cave rescue specialists
(13) Mine rescue specialists
(14) Other technical search and/or rescue providers and managers

A.10.3.3(4) Body management refers to the skills and knowledge involved in maintaining personal nutrition, hydration, rest, and other physiological requirements of the human body.

A.10.3.3(6) Personal support equipment should include that which is necessary to address the following needs, or potential needs, of a rescuer in a wilderness setting:

(1) Personal medical (first aid) supplies
(2) Additional clothing appropriate for anticipated environment/weather
(3) Fluids and food appropriate for mission duration
(4) Personal safety and comfort gear (e.g., flashlight, sunglasses, sunscreen)
(5) Navigation tools (e.g., compass, map)
(6) General marking and documentation tools (e.g., flagging tape, paper/pencil)
(7) Improvisational tools (e.g., wire, twine, leaf bag, safety pin)
(8) Emergency shelter, bivouac, and/or body protection
(9) Emergency communications (e.g., whistle, radio, flare)
(10) Pack for contents (e.g., belt pack, rucksack)

A.10.3.3(7) The AHJ should establish procedures for negotiating and/or avoiding conditions and hazards specific to the wilderness environments and terrains in which rescuers can become involved. It is likely that some conditions and/or situations will exceed the capability of the organization. In such situations, additional, more experienced, specialized, or highly trained resources should be procured. *[See also A.10.3.3(12).]*

A.10.3.3(12) Skills involved in supporting and participating in a search should include, but not be limited to, the following:

(1) Hasty, efficient, and thorough search techniques
(2) Principles of confinement of the search area
(3) Principles and importance of clue awareness
(4) Basic search theory application and terminology
(5) Principles of lost person behavior
(6) Procedures for serving as an air observer (e.g., searching from an aircraft)
(7) Procedures for handling, processing, and documenting evidence

A.10.3.3(16) The ability to discern limitations in accessing and/ or evacuating should be based on the following:

(1) Individual and team expertise
(2) Qualified personnel available
(3) Ability to communicate from the patient scene
(4) Anticipated staffing and time

A.10.4.4(4) Members of an organization at the technician level should be adept and experienced at every skill required of subordinate personnel. Technician-level organizations should have the capability to address any potential operation that falls within their jurisdiction. To accomplish this, members of these organizations should be personally adept at wilderness skills, travel, and operations in the wilderness setting.

A.10.4.4(5) Such an operational plan should be based on the hazard identification and risk assessment performed according to Section 4.2, available resources, environmental influences and conditions, and the urgency of the

situation. Specifically with regard to a search, the implemented plan should involve planning and search management techniques including, but not necessarily limited to, the following:

(1) Determining the urgency of the search
(2) Developing a lost subject profile
(3) Establishing the search area and correctly dividing it into regions and segments as necessary
(4) Conducting an appropriate investigation and interviews
(5) Applying the mathematical concept of probability and search theory
(6) Designing, developing, and establishing appropriate search strategy and tactics
(7) Establishing and managing appropriate base camp
(8) Briefing and debriefing of operational personnel properly and thoroughly
(9) Considering suspension of the search when appropriate
(10) Demobilizing personnel and facilities
(11) Documenting the incident properly

A.11.2.3(2) See A.5.2.2(2).

A.11.2.3(3) The emergency response system includes, but is not limited to, operations- and technician-level organizations capable of responding to various types of search and rescue incidents, as well as local, state, and national resources.

A.11.2.3(4) These procedures should include the process of achieving and maintaining control of the site and the perimeter. This control might include management of all civilian and nonemergency personnel and establishment of operational zones and site security.

A.11.2.3(5) General hazards associated with search and rescue operations at trench and excavation collapses can present the AHJ with uniquely challenging situations. The AHJ should consider the following potential hazards when providing training to its members:

(1) *Utilities.* Control of the utilities in and around a trench or excavation emergency is critical to ensure the safety of responding personnel and victims. The AHJ should provide its members with training in the control of these services to provide a safe environment in which to operate and to ensure the safety of victims. The following utilities should be considered when providing training:
    (a) Electrical services (primary and secondary)
    (b) Gas, propane, fuel oil, or other alternative energy sources (primary systems)
    (c) Water/steam
    (d) Sanitary systems
    (e) Communications
    (f) Secondary service systems (such as compressed, medical, or industrial gases)
(2) *Hazardous Materials.* Excavations might include various materials unique to a site that, when released during a collapse, could pose a hazard to victims and responders. The AHJ should provide members with training in the recognition of potential hazardous material releases, the determination of an existing hazard, and the methods used to contain, confine, or divert hazardous materials to conduct operations safely and effectively.
(3) *Personal Hazards.* At the site of any trench or excavation collapse, there are many dangers that pose personal injury hazards to the responders. The AHJ should train members to recognize the personal hazards they encounter and to use the methods needed to mitigate these hazards to help ensure their safety. Every member should be made aware of hazards such as trips, falls, blows, punctures, impalement, and so forth.
(4) *Confined Space.* All trench and many excavation collapses necessitate a confined space rescue. Responding personnel should be familiar with and trained in confined space rescue requirements and techniques. The AHJ should determine the applicable laws and standards related to confined space rescue and should provide training to members in confined space rescue.
(5) *Other Hazards.* There are numerous other hazards associated with trench and excavation collapses. The AHJ should make every effort to identify the hazards that might be encountered within the jurisdiction and should provide members with training and awareness of these other hazards to allow them to perform rescue operations safely and effectively.

The “general area” around a trench or excavation emergency is the entire area within 92 m (300 ft) (or more, as established by the incident commander). Making the general area safe includes, but is not necessarily limited to, the following:

(1) Controlling/limiting traffic and sources of vibration in the area, including shutting down all vehicles and equipment
(2) Controlling/limiting access to the area by unnecessary personnel
(3) Identifying hazards and removing and/or reducing their impact

A.11.2.3(6) The types of collapse normally encountered at an excavation or trench incident include the following:

(1) Spoil pile collapse — where the excavated earth piled on the side of the trench slides into the trench
(2) Shear wall collapse — where one side of the trench shears away from the wall of the trench
(3) Slough collapse — where a belowgrade section collapses, leaving the potential for the collapse of an overhanging ledge

The reasons and indicators of initial and secondary collapse of trenches and excavations are usually related to one or more of the following site characteristics:

(1) Unprotected trench (lack of protection systems)
(2) Static loads
(3) Standing water or water seeping into trench
(4) Intersecting trenches
(5) Vibrations (from vehicles, nearby roads, airports, etc.)
(6) Previously disturbed soil
(7) Exterior cracking of trench walls

A.11.2.3(7) Rapid, nonentry rescues include placing a ladder to allow a victim to perform a self-rescue or allowing uninjured persons in the trench to remove a victim.

A.11.2.3(8) As a rule of thumb, a cubic foot of soil weighs 100 lb, a cubic yard weighs 1.5 tons, and a cubic meter weighs 1600 kg. The weight and movement of soil alone can cause crush injuries, and the characteristics of the soil (e.g., wet, hard, sandy) will dictate how the soil will entrap (e.g., flow around, drown) a victim.

A.11.3.2 Severe environmental conditions include operations involving frozen soil, running soil (e.g., gravel, sand, liquid), severe weather (e.g., heavy rain, wind, or flooding), or night (dark) operations. Supplemental sheeting and shoring includes operations that involve the use of commercial sheeting/shoring systems and/or isolation devices, or cutting and placement of sheeting and shoring when greater than 0.6 m (2 ft) of shoring exists below the bottom of the strongback. Supplemental sheeting and shoring requires additional training beyond that of traditional sheeting and shoring. Traditional sheeting and shoring involves the use of 1.2 m ×2.4 m (4 ft ×8 ft) sheet panels with a strongback attachment supplemented by a variety of conventional shoring options such as hydraulic, pneumatic, and/or screw shores.

Commercial sheeting/shoring systems and devices include trench boxes, sheet piles, plate steel, and the like. Isolation devices include concrete pipes, concrete vaults, steel pipe, or anything that serves to separate the victim(s) from the surrounding soil.

A.11.3.3(1) The size-up should include, but not be limited to, the initial and continuous evaluation of the following:

(1) Scope, magnitude, and nature of the incident
(2) Location and number of victims
(3) Risk/benefit analysis (body recovery versus rescue)
(4) Exposure to traffic and sources of vibration
(5) Hazards such as disrupted or exposed utilities, standing or flowing water, secondary collapse, mechanical hazards, hazmat, and explosives
(6) Trench/excavation dimensions
(7) Access to the scene
(8) Environmental factors
(9) Available/necessary resources

A.11.3.3(3) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning should be provided to ensure the stability of such structures for the protection of employees. Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees should not be permitted except when one of the following occurs:

(1) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure.
(2) The excavation is in stable rock.
(3) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity.
(4) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees. Sidewalks, pavements, and appurtenant structures should not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

A.11.3.3(4) Procedures to identify probable victim locations include the following:

(1) Visualization of the victim
(2) Presence of drink cups or food containers, work tools, laser targets, buckets, grade poles, grease and brush, engineers' hubs, or anything that can indicate the victim's last probable physical location
(3) Information from bystanders
(4) End of pipe string
(5) Sounds in pipes
(6) “Cat” or tire tracks

A.11.3.3(5) The rescue area is that area immediately surrounding the trench and/or excavation site. Making the rescue area safe includes, but is not limited to, the following actions; however, specific actions should be based on both the type of collapse and the soil type.

(1) Utilizing sheeting and shoring to stabilize trench/excavation walls
(2) Making the trench/excavation safe for entry
(3) Safely undertaking disentanglement operations in the trench/excavation
(4) Placing ground pads at the lip of the trench/excavation
(5) Ventilating the trench and monitoring its atmosphere
(6) Dewatering
(7) Supporting any unbroken utilities
(8) Providing a helmet and goggles for a victim, if possible
(9) Prohibiting entry into an unsafe trench/excavation
(10) Preventing the touching or operating of heavy equipment until its safety has been established

The term *tabulated data* usually refers to the six tables found in Appendix C of 29 CFR 1926, Subpart P. Traditional sheeting and shoring should not be used in situations that exceed the tabulated data for timber trench shoring presented in 29 CFR 1926, Subpart P. Also, these systems should not be used where they would be submerged in water.

A.11.3.3(6) In many parts of the United States, a one-call underground utility location service is available to contractors and residents who are preparing to excavate. By making one telephone call (usually a toll-free number), excavators can learn the location of all underground utility installations in the area of the planned excavation. This service quickly notifies all possible utility providers in the area who, in turn, either indicate that there is no utility in the area or have someone go to the site to mark the utilities. Such a service can be invaluable to emergency responders at the site of a trench or excavation emergency incident.

Where no one-call system exists, all utility companies that might have underground equipment at or near the excavation site must be notified so they can have a representative respond to mark underground utility locations.

A.11.3.3(7) See Annex J.

A.11.3.3(11) A ladder or engineered ramp can be required for entry or egress from a trench. For instance, 29 CFR 1926.651(c)(1)(v) requires, "A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for employees."

A.11.3.3(12) The pre-entry briefing should include, but not be limited to, information regarding the following:

(1) Tactical assignments with explicit instructions
(2) General hazards and safety instructions
(3) Communications protocols, procedures, and details
(4) Anticipated environmental concerns
(5) Time frames for operations
(6) Emergency procedures
(7) Specific equipment needs
(8) Debriefing procedures
(9) Anticipated logistical needs

A.11.3.3(13) Documentation for entry operations, as a minimum, should include the following:

(1) Development of some type of representation of IMS command structure
(2) Time of incident
(3) Total time of operation
(4) Environmental conditions
(5) Location of victim
(6) Creation of a tactical checklist that includes entry times, exit times, personal accountability reports, atmospheric readings, rehabilitation information, injuries sustained, and incident number

A.11.3.3(15) See Annex B for information on sloping and benching systems.

A.11.3.3(18) Procedures for disentanglement and removing the entrapment mechanism can include, but are not limited to, the following:

(1) Hand digging
(2) Lifting using air bags, pneumatic, or other mechanical advantage devices
(3) Suctioning
(4) Cutting using air knives, saws, or other power tools
(5) Dewatering
(6) Use of heavy equipment

Procedures and equipment involved in removal systems should comply with NFPA 1983, *Standard on Fire Service Life Safety Rope and System Components*.

Heavy or mechanical equipment and/or mechanical winches of any kind should not be used to physically lift, pull, or extricate victims from a trench. However, there can be circumstances when heavy equipment can be appropriate for accessing victims of trench and evacuation emergencies with the appropriate level of supervision and after careful consideration is given to the negative impact of such actions on the victim, including the effects of extreme superimposed loads and vibration adjacent to the trench. For example, heavy equipment might be used to dig an adjacent trench or hole for access, but the excessive loading and vibration of the area adjacent to the trench can cause a rapid deterioration in the condition of, and in the immediate environment surrounding, the victim. In any case, to best establish viable options and available capabilities, the advice of experienced and knowledgeable on-site personnel should be sought in order to make the best possible decisions.

A.11.4.2 See A.11.3.2.

A.11.4.3(2) Manufactured protection systems include trench boxes, rabbit boxes, "coffins," rigging and placement of sheetpiles, rigging and placement of plate steel, or other similar commercial systems. *[See also 11.3.3(4).]*

A.11.4.3(3) Personnel meeting the requirements of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, should perform the monitoring procedures even if such personnel are not part of the rescue team. Important information regarding these procedures include, but are not limited to, the following:

(1) Acceptable limits for oxygen concentration in air should be between 19.5 percent and 23.5 percent. An oxygen-enriched atmosphere is considered to be greater than 23.5 percent and poses a flammability hazard. An oxygen-deficient atmosphere is considered to be lower than 19.5 percent and can lead to asphyxiation without fresh-air breathing apparatus.

(2) Flammability is measured as a percentage of a material's lower explosive limit (LEL) or lower flammable limit (LFL). Rescuers should not enter confined spaces containing atmospheres greater than 10 percent of a material's LEL regardless of the personal protective equipment worn. There is no adequate protection for an explosion within a confined space.

(3) Acceptable toxicity levels are specific to the hazardous material involved, and chemical properties should be assessed to determine the level of the hazard for a given environment and time frame.

A.11.4.3(6) In certain soil and environmental conditions, it can be necessary to isolate the victim to disentangle him or her effectively. For instance, in sand, grain, pea gravel, coal slag, or any type of running product, it can be necessary to isolate the victim physically from the surrounding product to free him or her. Examples of isolation devices include concrete or steel pipe, corrugated pipe, concrete vaults, or other pre-engineered structures that sufficiently isolate and protect the victim.

Annex B Sloping and Benching

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1

The following material describes and defines sloping and benching as used in this standard and is excerpted from Appendix B (Excavations, Sloping and Benching) of 29 CFR 1926, Subpart P.

(1) *Scope and application*. This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in 1926.652(b)(2).

(2) *Definitions*.

"Actual slope" means the slope to which an excavation face is excavated.

"Distress" means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and ravelling, e.g., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

"Maximum allowable slope" means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

"Short term exposure" means a period of time less than or equal to 24 hours that an excavation is open.

(3) *Requirements*.

(a) Soil classification. Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(b) Maximum allowable slope. The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(c) Actual slope.

i. The actual slope shall not be steeper than the maximum allowable slope.

ii. The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½ H:1V) less steep than the maximum allowable slope.

iii. When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with 1926.651(i).

(d) Configurations. Configurations of sloping and benching systems shall be in accordance with Figure B.1.1.1(a) through Figure B.1.1.3(c).

Table B.1 Maximum Allowable Slopes

Soil or rock type	Maximum allowable slopes (H:V)(1) for excavations less than 20 feet deep (3)
Stable rock	Vertical (90 Deg.)
Type A (2)	¾:1 (53 Deg.)
Type B	1:1 (45 Deg.)

Type C	1½:1 (34 Deg.)

Notes:
[1]Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
[2] A short-term maximum allowable slope of ½H:1V (63 degrees) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be ¾H:1V (53 degrees).
[3] Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.
Source: 29 CFR 1926, Subpart P, Appendix B, Table B-1.

B.1.1 Excavations Made in Type A Soil.

B.1.1.1 All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1. *[See Figure B.1.1.1(a).]*

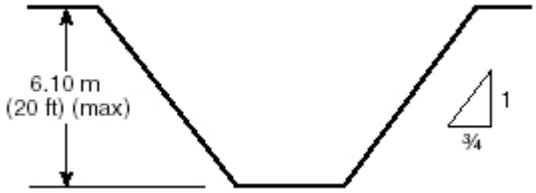


FIGURE B.1.1.1(a) Simple Slope — General. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.1(a)]***

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1. [See Figure B.1.1.1(b).]

FIGURE B.1.1.1(b) Simple Slope — Short Term. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.1(b)]***

B.1.1.2 All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows: *[See Figure B.1.1.2(a) and Figure B.1.1.2(b).]*

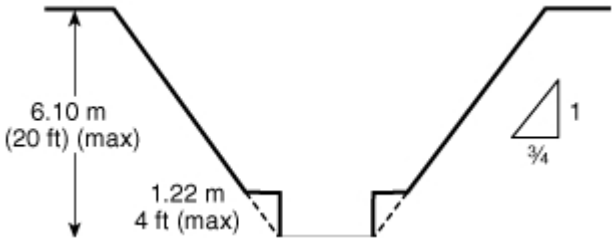


FIGURE B.1.1.2(a) Simple Bench. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.1(c)]***

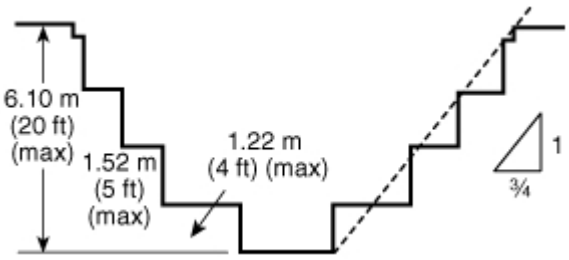


FIGURE B.1.1.2(b) Multiple Bench. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.2(d)]***

B.1.1.3 All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet. *[See Figure B.1.1.3(a).]*

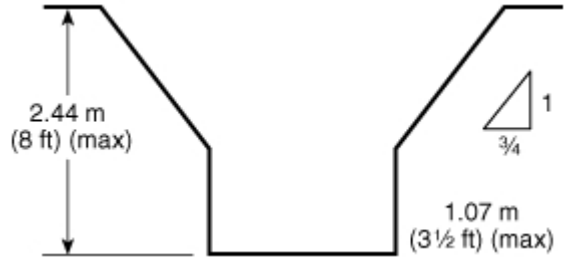


FIGURE B.1.1.3(a) Unsupported Vertically Sided Lower Portion — Maximum 8 Feet in Depth. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.3(e)]***

All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet. *[See Figure B.1.1.3(b).]*

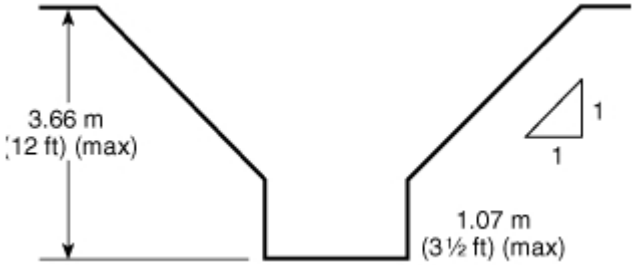


FIGURE B.1.1.3(b) Unsupported Vertically Sided Lower Portion — Maximum 12 Feet in Depth. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.3(f)]***

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side. *[See Figure B.1.1.3(c).]*

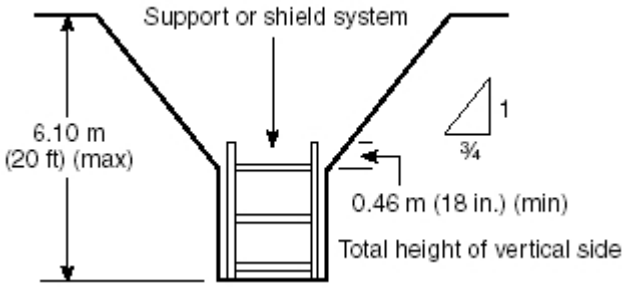


FIGURE B.1.1.3(c) Supported or Shielded Vertically Sided Lower Portion. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.1.3(g)]***

B.1.1.4 All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under 1926.652(b).

B.1.2 Excavations Made in Type B Soil.

B.1.2.1 All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1. *(See Figure B.1.2.1.)*

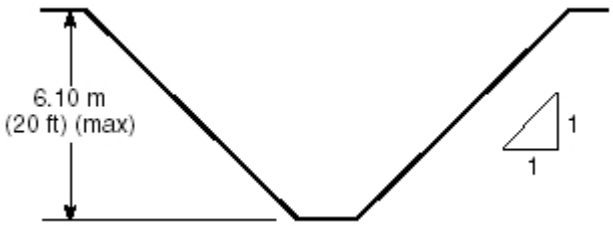


FIGURE B.1.2.1 Simple Slope. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.2.1]***

B.1.2.2 All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows: *[See Figure B.1.2.2(a) and Figure B.1.2.2(b).]*

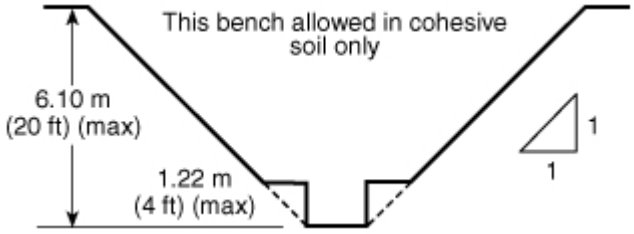


FIGURE B.1.2.2(a) Single Bench. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.2.2(a)]***

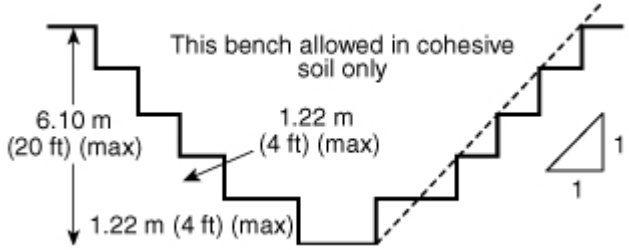


FIGURE B.1.2.2(b) Multiple Bench. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.2.2(b)]***

B.1.2.3 All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1. *(See Figure B.1.2.3.)*

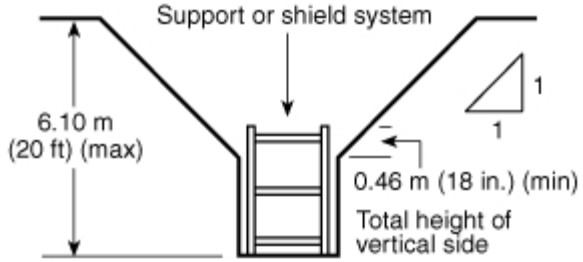


FIGURE B.1.2.3 Vertically Sided Lower Portion. ***(Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.2.3)***

B.1.2.4 All other sloped excavations shall be in accordance with the other options permitted in 1926.652(b).

B.1.3 Excavations Made in Type C Soil.

B.1.3.1 All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1. *(See Figure B.1.3.1.)*

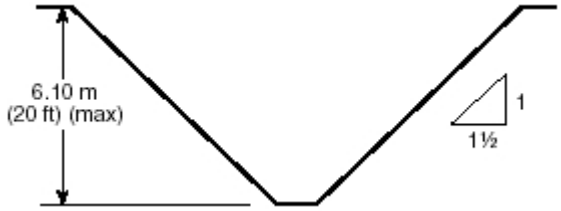


FIGURE B.1.3.1 Simple Slope. ***(Source: 29 CFR 1926, Subpart P, Appendix B, Figure B.1.3.1)***

B.1.3.2 All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1. *(See Figure B.1.3.2.)*

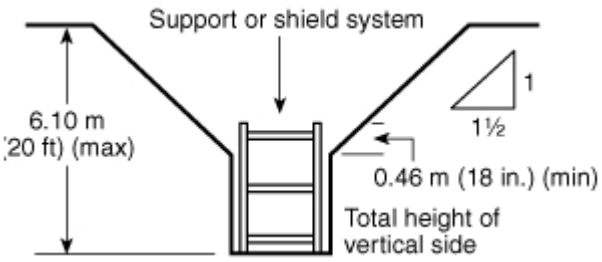


FIGURE B.1.3.2 Vertical Sided Lower Portion. ***(Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.3.2)***

B.1.3.3 All other sloped excavations shall be in accordance with the other options permitted in 1926.652(b).

B.1.4 Excavations Made in Layered Soils.

B.1.4.1 All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below. *[See Figure B.1.4.1(a) through Figure B.1.4.1(f).]*

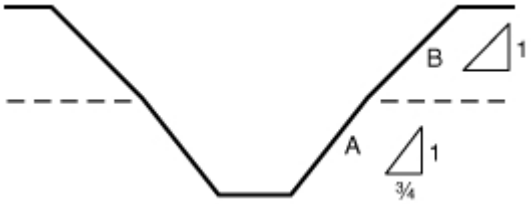


FIGURE B.1.4.1(a) B over A. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.4.1(a)]***

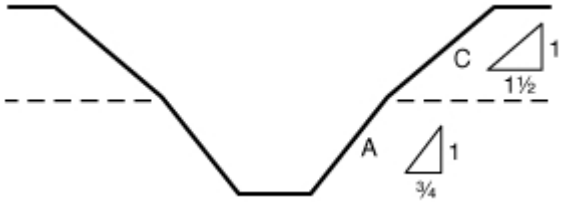


FIGURE B.1.4.1(b) C over A. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.4.1(b)]***

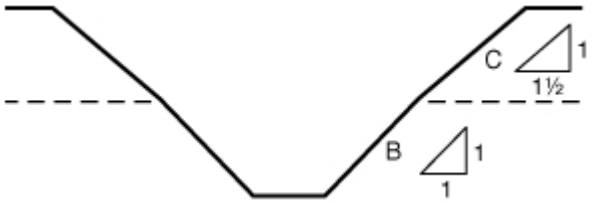


FIGURE B.1.4.1(c) C over B. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.4.1(c)]***

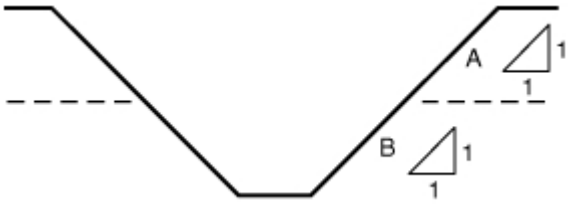


FIGURE B.1.4.1(d) A over B. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.4.1(d)]***

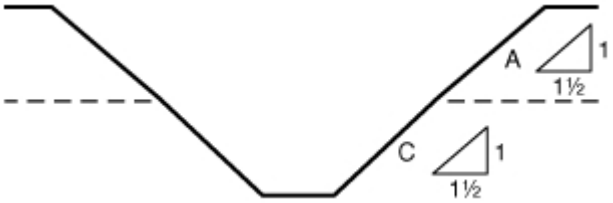


FIGURE B.1.4.1(e) A over C. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.4.1(e)]***

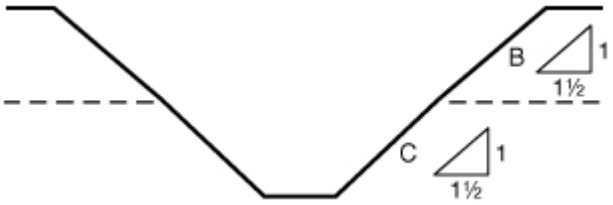


FIGURE B.1.4.1(f) B over C. ***[Source: 29 CFR 1926, Subpart P, Appendix B, Figure B-1.4.1(f)]***

B.1.4.2 All other sloped excavations shall be in accordance with the other options permitted in 1926.652(b).

Annex C Structural Types

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1

The material in Table C.1 and Figure C.1(a) through Figure C.1(n) can be used to clarify material found in the body of the document. Annex C is extracted from FEMA Earthquake Hazards Reduction Series 41, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook.*

Table C.1 Combinations of Materials in Structural Types (after ATC, 1987)

Structural Type Identifier	General Description
W	Wood buildings of all types
S1	Steel moment-resisting frames
S2	Braced steel frames
S3	Light metal buildings
S4	Steel frames with cast-in-place concrete shearwalls
C1	Concrete moment-resisting frames
C2	Concrete shearwall buildings
C3/C5	Concrete or steel frame buildings with unreinforced masonry in-fill walls
TU	Tilt-up buildings
PC2	Precast concrete frame buildings
RM	Reinforced masonry
URM	Unreinforced masonry

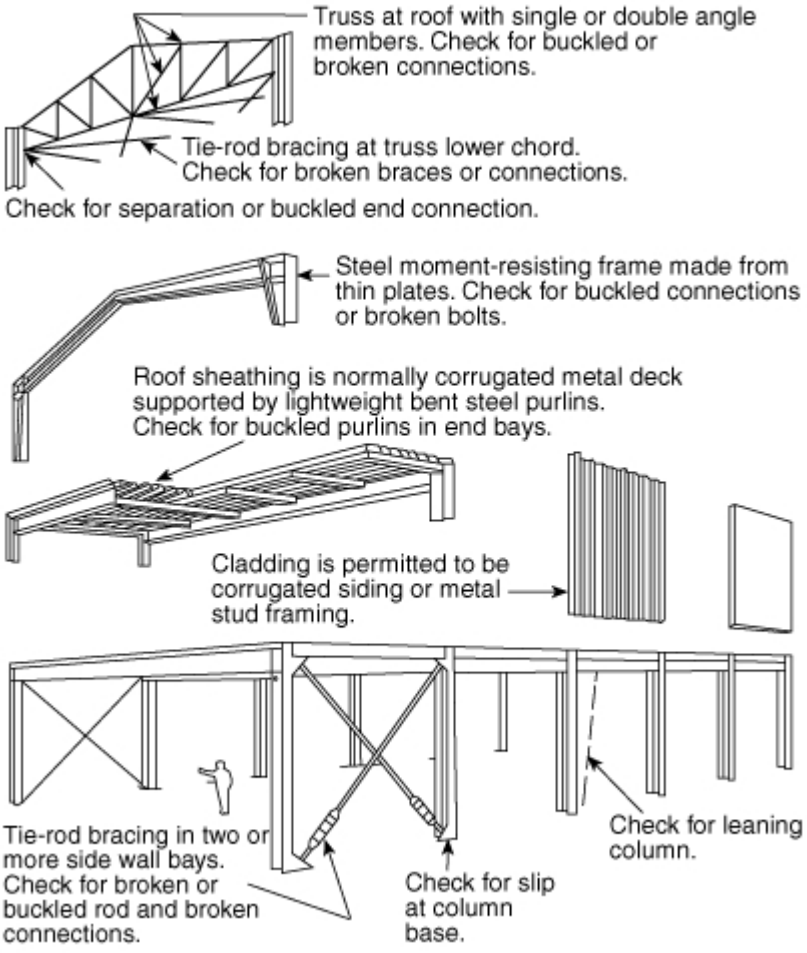


FIGURE C.1(a) Light Metal Buildings (S3).

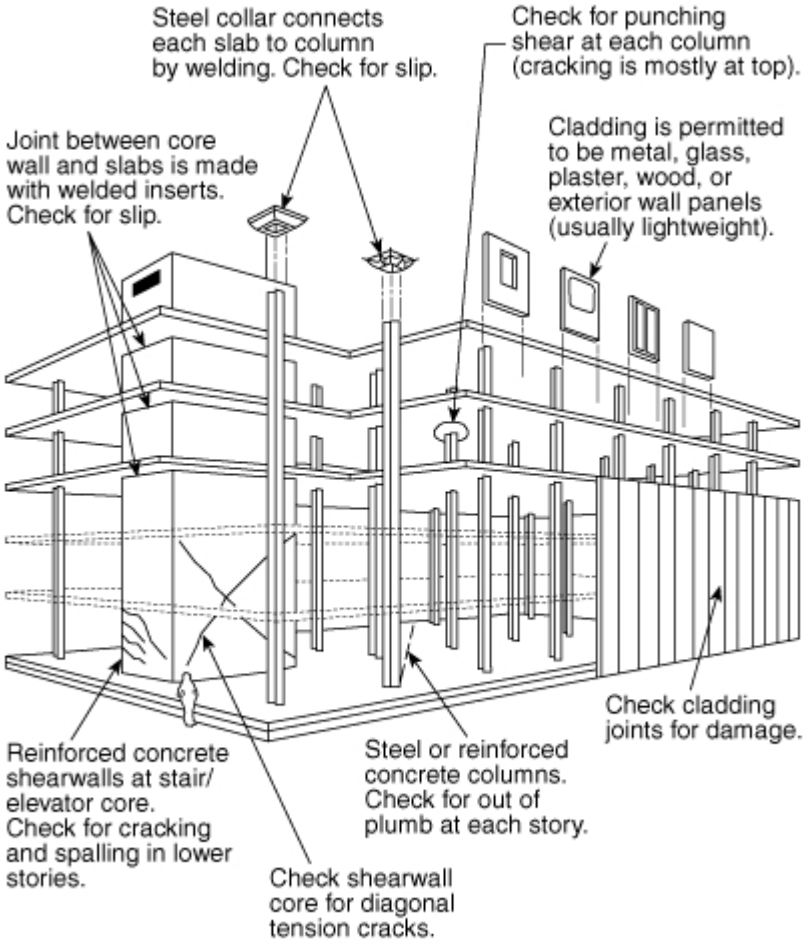
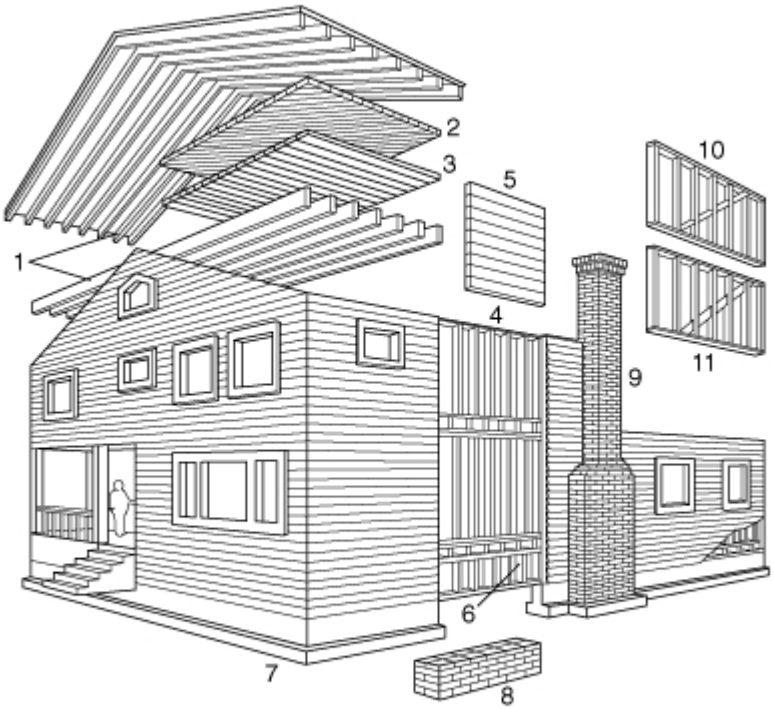


FIGURE C.1(b) Post-tensioned Lift Slab Building.

Roof/floor span systems:
1. Wood joist and rafter
2. Diagonal sheathing
3. Straight sheathing

Wall systems:
4. Stud wall
(platform or balloon framed)
5. Horizontal siding



Foundation/connections:
6. Unbraced cripple wall
7. Concrete foundation
8. Brick foundation

Bracing and details:
9. Unreinforced brick chimney
10. Diagonal blocking
11. Let-in brace (only in later vintages)

FIGURE C.1(c) Wood Stud Frame Construction.

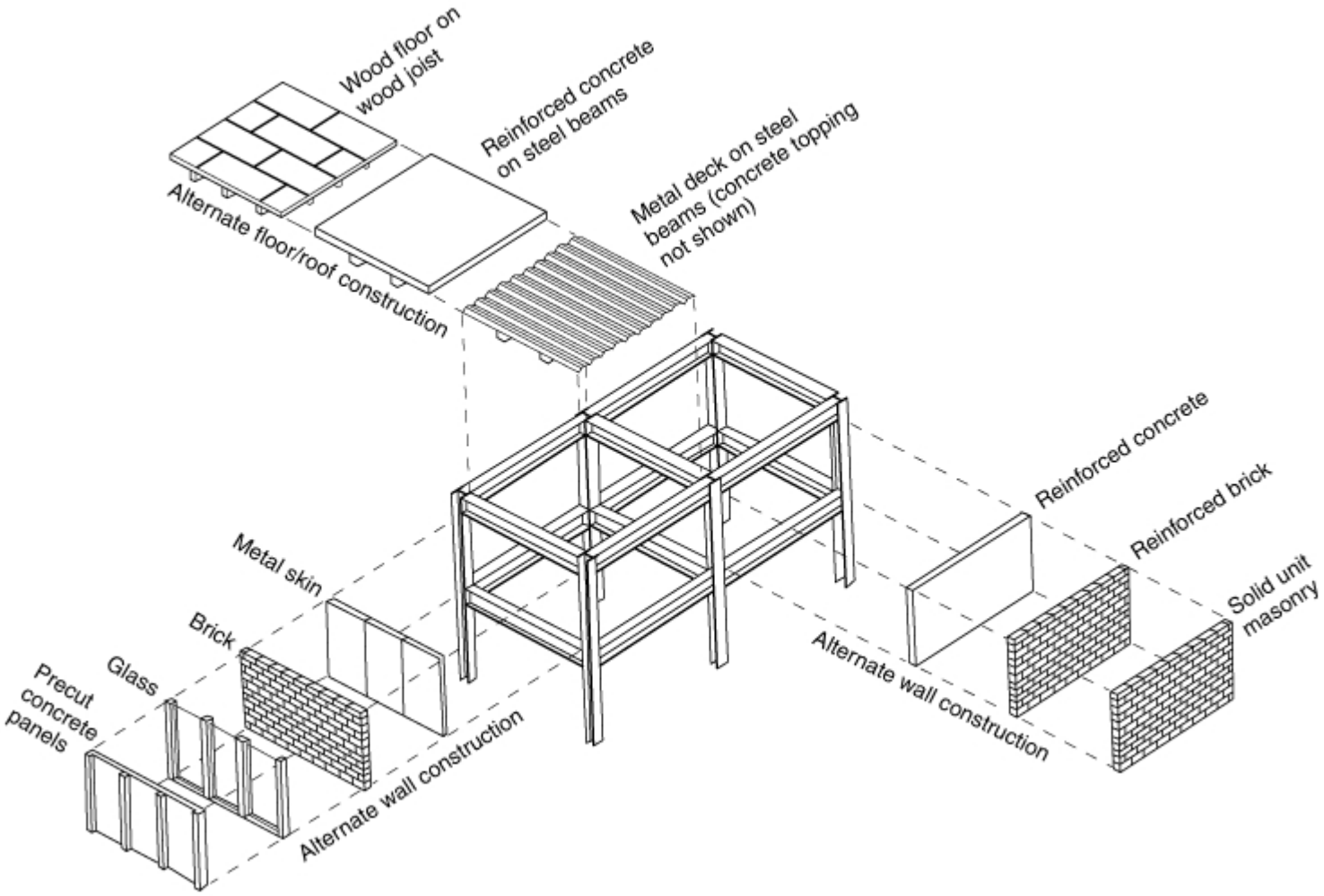


FIGURE C.1(d) Steel Moment-Resisting Frame.

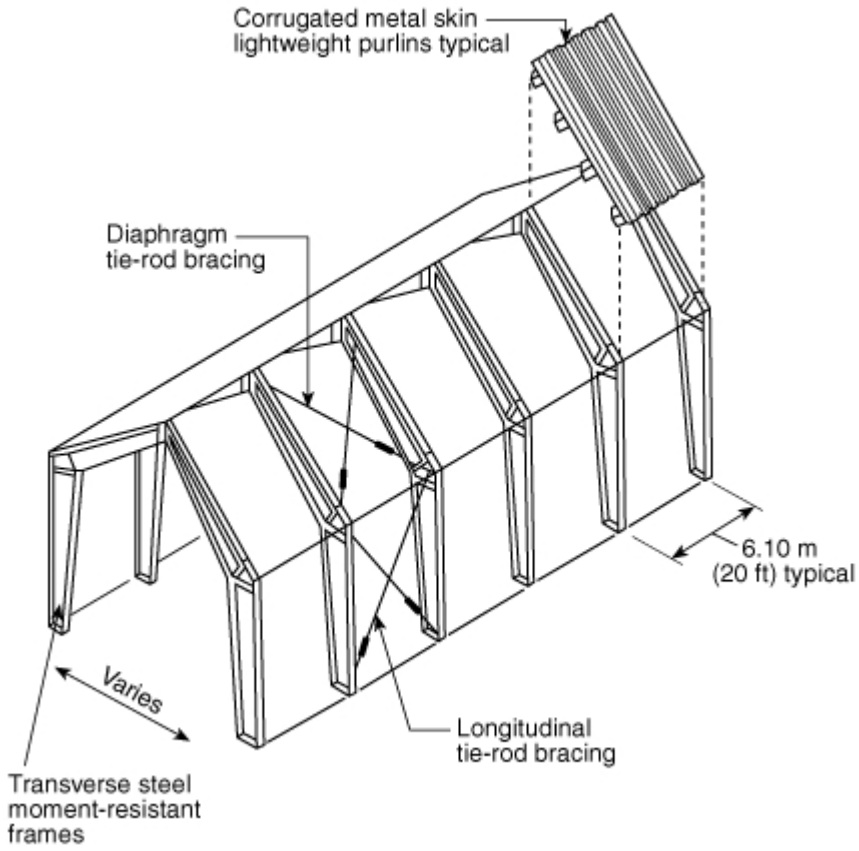


FIGURE C.1(e) Light Metal Construction.

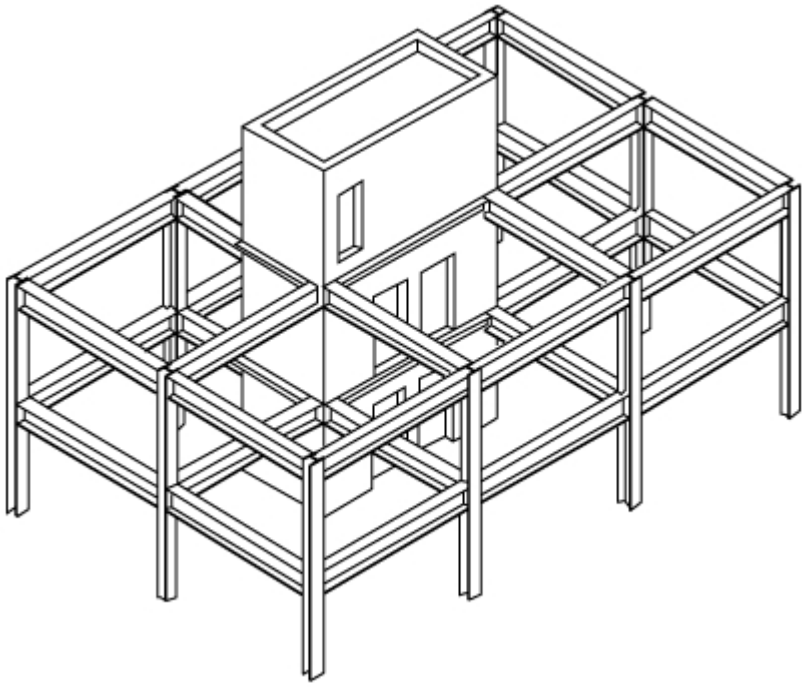
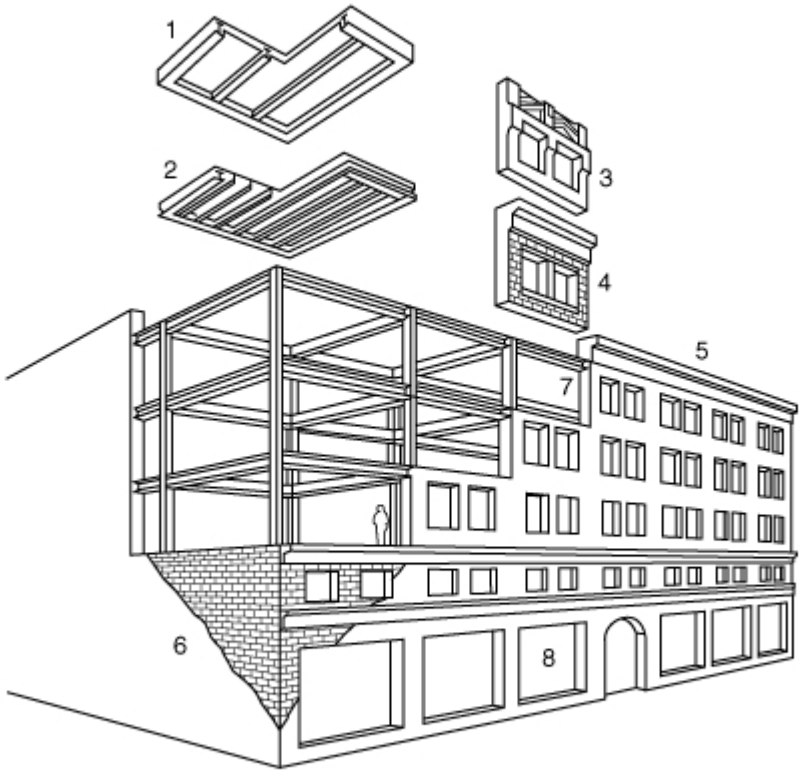


FIGURE C.1(f) Steel Frame with Shearwall.

Roof/floor span systems:
1. Steel framing with concrete cover
2. Wood floor joist and diaphragm (diagonal and straight)

Wall systems:
3. Non-load-bearing concrete wall
4. Non-load-bearing unreinforced masonry cover wall



Details:
5. Unreinforced and unbraced parapet and cornice
6. Solid party walls

Openings and wall penetrations:
7. Window-penetrated front facade
8. Large openings of street-level shops

FIGURE C.1(g) Steel Frame with Unreinforced Masonry (URM) In-Fill.

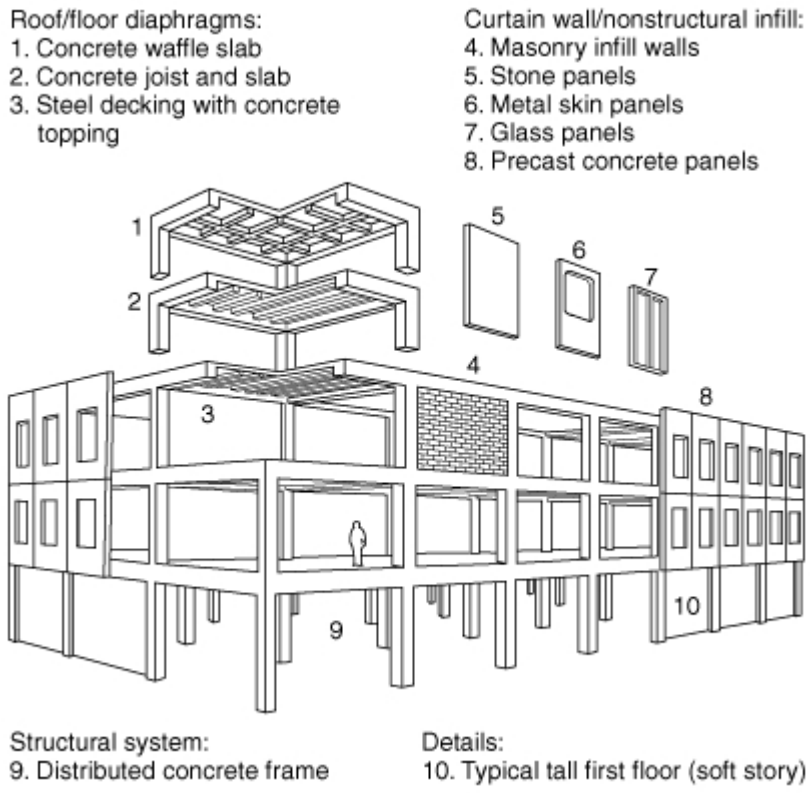


FIGURE C.1(h) Concrete Moment-Resisting Frame.

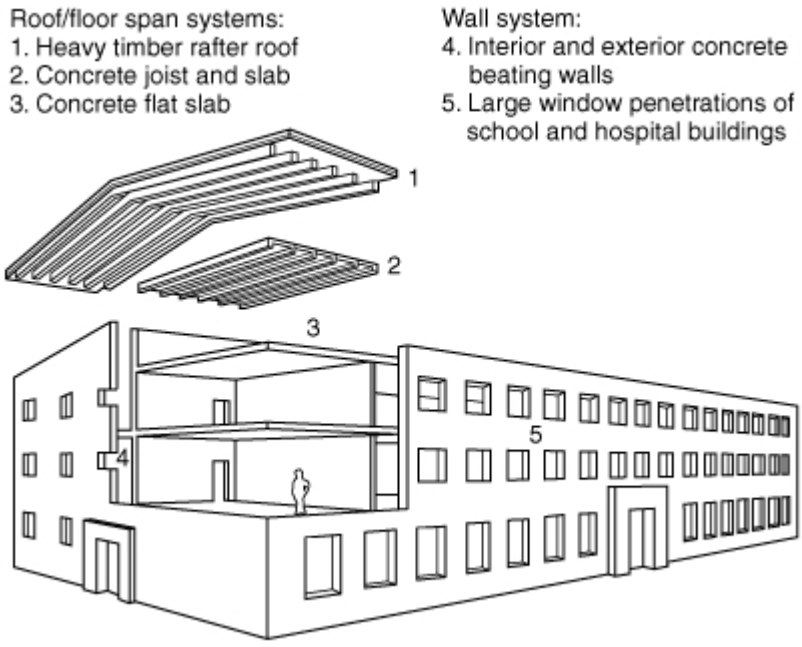


FIGURE C.1(i) Concrete Shearwall.

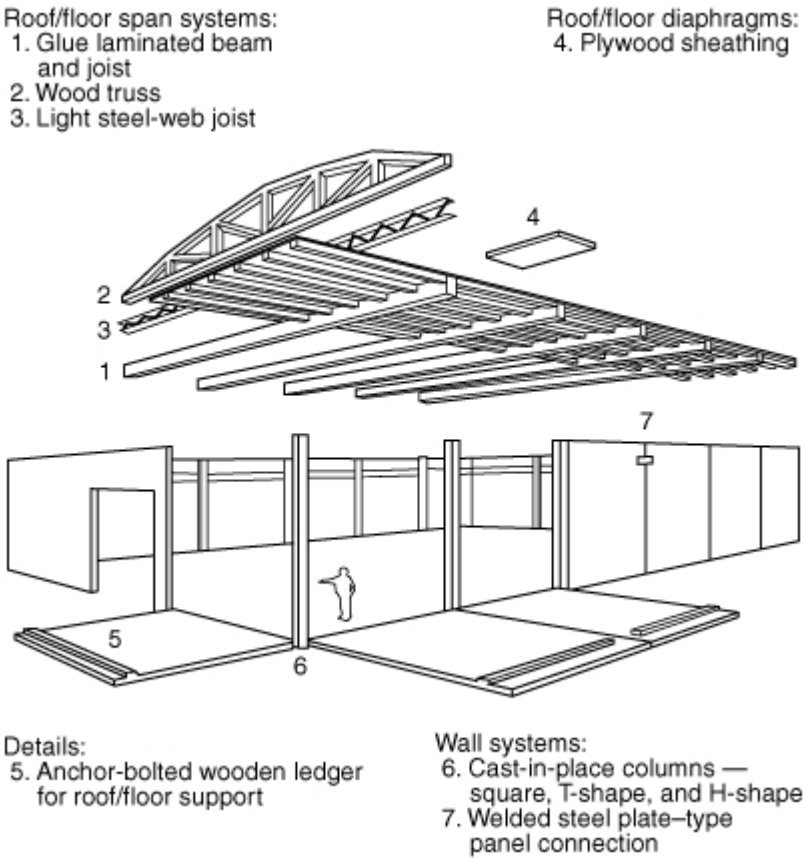
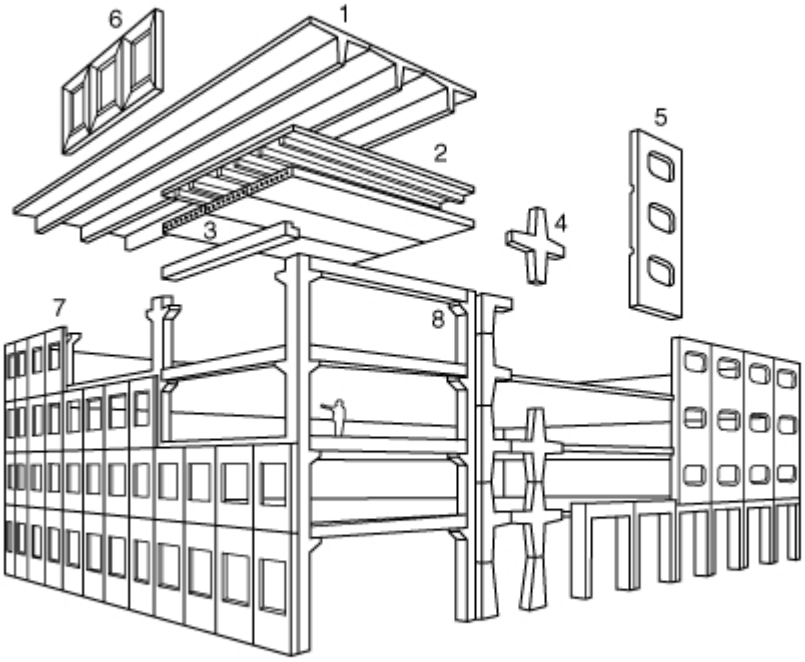


FIGURE C.1(j) Tilt-Up Construction Typical of the Western United States; Tilt-Up Construction in the Eastern United States Can Incorporate a Steel Frame.

Roof/floor span systems:
1. Structural concrete T sections
2. Structural double T sections
3. Hollow-core concrete slab

Wall systems:
4. Load-bearing frame components (cross)
5. Multistory load-bearing panels



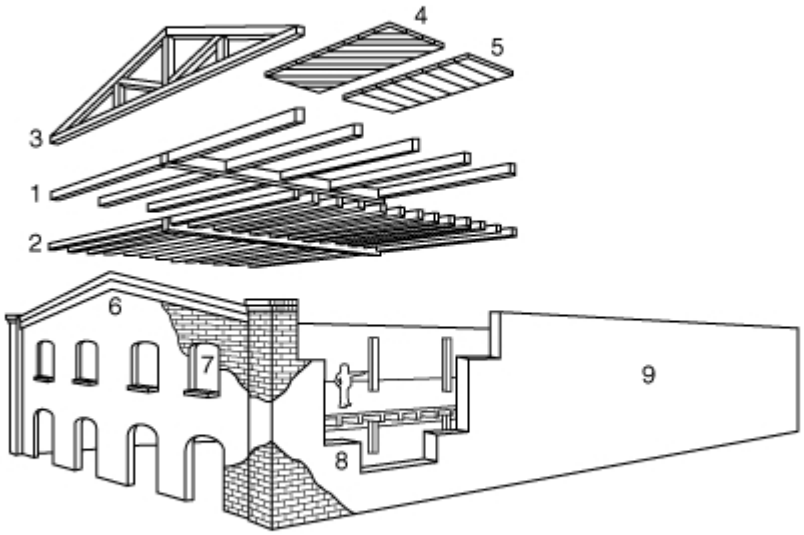
Curtain wall system:
6. Precast concrete panels
7. Metal, glass, or stone panels

Structural system:
8. Precast column and beams

FIGURE C.1(k) Precast Concrete Frame.

Roof/floor span systems:
1. Wood post and beam (heavy timber)
2. Wood post, beam, and joist (mill construction)
3. Wood truss-pitch and curve

Roof/floor diaphragms:
4. Diagonal sheathing
5. Straight sheathing



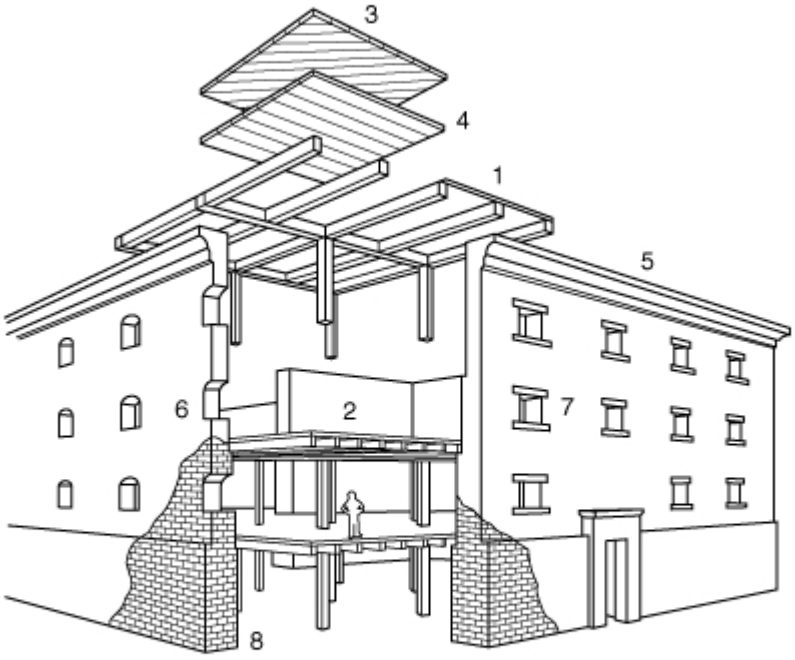
Details:
6. Typical unbraced parapet and cornice
7. Flat arch window openings

Wall systems:
8. Bearing wall — four or more wythes of brick
9. Typical long solid party wall

FIGURE C.1(l) Unreinforced Masonry Bearing Wall, Example 1 of 3.

Roof/floor span systems:
1. Wood post and beam (heavy timber)
2. Wood post, beam, and joist (mill construction)

Roof/floor diaphragms:
3. Diagonal sheathing
4. Straight sheathing



Details:
5. Typical unbraced parapet and cornice
6. Flat arch window openings
7. Small window penetrations (if building is originally a warehouse)

Wall systems:
8. Bearing wall — four to eight wythes of brick

FIGURE C.1(m) Unreinforced Masonry Bearing Wall, Example 2 of 3.

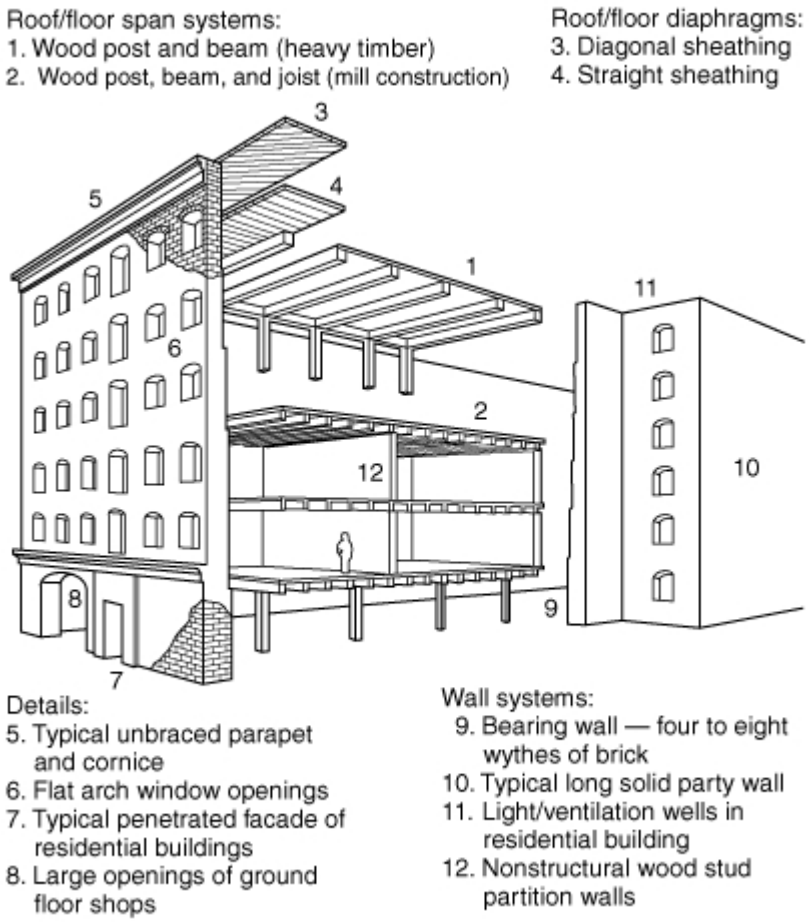


FIGURE C.1(n) Unreinforced Masonry Bearing Wall, Example 3 of 3.

Annex D Sample Course Outlines

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1

The following outlines are provided as an aid to the user of this document in developing training for personnel who will be involved in the various organizational levels of the search and rescue disciplines defined in this document.

D.2 Rope Rescue — Course Outline.

I. AWARENESS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of recognizing conditions requiring rope rescue and making appropriate notifications to begin the rescue process.

B. PREREQUISITES: None

C. CONTENT:

(1) Three-tiered concepts (awareness, operations, technician) of NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, describing the operational capability of organizations and individuals

(2) Procedures for initiating the emergency response system where rope rescue is required

(3) Procedures for carrying out site control and scene management

(4) Procedures for recognizing general hazards associated with rope rescue and the procedures necessary to mitigate these hazards

(5) Procedures for identifying and utilizing personal protective equipment assigned for use at a rope rescue incident

II. OPERATIONS LEVEL: LOW-ANGLE

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and the techniques necessary to operate at rope rescue incidents.

B. PREREQUISITES: Meet all awareness-level requirements

C. CONTENT:

(1) Procedures for sizing up existing and potential conditions
- (a) Scope, magnitude, and nature of the incident
- (b) Location, number, and condition of victims
- (c) Risk/benefit analysis (body recovery versus rescue)
- (d) Access to the scene
- (e) Environmental factors
- (f) Available/necessary resources
- (g) Patient contact when it can be performed without endangering either responders or victims

(2) Procedures for ensuring safety in rope rescue operations
- (a) Edge protection
- (b) Belays
- (c) Critical angles in rope systems
- (d) System stresses
- (e) Safety checks

(3) Procedures for establishing the need for, selecting, and placing edge protection

(4) Procedures for selecting, using, and maintaining rope rescue equipment and rope rescue systems

(5) Procedures for configuring all knots, bends, or hitches used by the organization
- (a) Bowline
- (b) Figure-eight family of knots and bends
- (c) Grapevine or double fisherman's knot

(d) Water knot
(e) Barrel knot
(f) Any knots, hitches, or bends used by the organization

(6) Procedures for selecting anchor points and equipment to construct anchor systems
(7) Procedures for constructing and using single-point anchor systems commensurate with the organization's needs
(8) Procedures for constructing and using multiple-point, load-sharing anchor systems commensurate with the organization's needs
(9) Procedures for selecting, constructing, and using a belay system commensurate with the organization's needs
(10) Procedures for selecting and using methods necessary to safely negotiate an edge or other obstacle
(11) How to ascend and descend a fixed rope
(12) Procedures for personnel to escape from jammed or otherwise malfunctioning ascent and descent control devices
(13) Procedures for selecting, constructing, and using a lowering system commensurate with the organization's needs
(14) Attaching a litter to a rope rescue system
(15) Utilization of litter attendants
(16) Selection, construction, and use of rope-based mechanical advantage systems
(17) Selection, construction, and use of raising systems

III. OPERATIONS LEVEL: HIGH-ANGLE

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and the techniques necessary to operate at rope rescue incidents.

B. PREREQUISITES: Meet all operations-level low-angle requirements

C. CONTENT:

(1) Procedures for sizing up existing and potential conditions
(a) Scope, magnitude, and nature of the incident
(b) Location, number, and condition of victims
(c) Risk/benefit analysis (body recovery versus rescue)
(d) Access to the scene
(e) Environmental factors
(f) Available/necessary resources
(g) Patient contact when it can be performed without endangering either responders or victims

(2) Procedures for ensuring safety in rope rescue operations
(a) Edge protection
(b) Belays
(c) Critical angles in rope systems
(d) System stresses
(e) Safety checks

(3) Procedures for establishing the need for, selecting, and placing edge protection
(4) Procedures for selecting, using, and maintaining rope rescue equipment and rope rescue systems
(5) Procedures for configuring all knots, bends, or hitches used by the organization
(a) Bowline
(b) Figure-eight family of knots and bends
(c) Grapevine or double fisherman's knot
(d) Water knot
(e) Barrel knot

(f) Any knots, hitches, or bends used by the organization

(6) Procedures for selecting anchor points and equipment to construct anchor systems

(7) Procedures for constructing and using single-point anchor systems commensurate with the organization's needs

(8) Procedures for constructing and using multiple-point, load-sharing anchor systems commensurate with the organization's needs

(9) Procedures for selecting, constructing, and using a belay system commensurate with the organization's needs

(10) Procedures for selecting and using methods necessary to safely negotiate an edge or other obstacle

(11) How to ascend and descend a fixed rope

(12) Procedures for personnel to escape from jammed or otherwise malfunctioning ascent and descent control devices

(13) Procedures for selecting, constructing, and using a lowering system commensurate with the organization's needs

(14) Attaching a litter to a rope rescue system

(15) Utilization of litter attendants

(16) Selection, construction, and use of rope-based mechanical advantage systems

(17) Selection, construction, and use of raising systems

IV. TECHNICIAN LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and techniques necessary to operate and supervise a rope rescue incident.

B. PREREQUISITES: Meet all operations-level requirements

C. CONTENT:

(1) Procedures for evaluating existing and potential conditions

(2) Procedures for understanding the basic physics involved in constructing rope rescue systems

(a) System safety factors

(b) Critical angles

(c) Causes and effects of force multipliers within rope rescue systems

(3) Procedures for negotiating obstacles while on a fixed rope

(4) Constructing and using multiple-point, load-distributing anchor systems

(5) Procedures for passing knots through a rope rescue raising or lowering system

(6) Construction of an elevated point to facilitate the safe transition of rescuers or victims over difficult edges

(7) Selection, construction, and use of a high-line rope system

(8) Procedures for utilizing a high-line rope system

(a) Transport rescuers

(b) Transport equipment

(c) Transport an occupied litter

(9) Procedures for utilizing litter attendants within a high-line rope system

D.3 Confined Space Search and Rescue — Course Outline.

I. AWARENESS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of recognizing conditions requiring confined space rescue and making appropriate notifications to begin the rescue process.

B. PREREQUISITES: None

C. CONTENT:

(1) Three-tiered concepts (awareness, operations, technician) of NFPA 1670, describing the operational capability of organizations and individuals

(2) Procedures for recognizing the need for confined space search and rescue

(3) Procedures for initiating contact and establishing communications with victims
(4) Procedures for recognizing and identifying the hazards associated with nonentry confined space emergencies
    (a) Hazardous atmospheres
    (b) Hazardous chemicals
    (c) Temperature extremes
(5) Procedures for recognizing confined spaces
(6) Procedures for performing a nonentry retrieval
(7) Procedures for implementing the emergency response system for confined space emergencies
(8) Procedures for implementing site control and scene management

II. OPERATIONS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and the techniques necessary to operate at confined space rescue incidents.

B. PREREQUISITES: Meet all awareness-level requirements

C. CONTENT:

(1) Procedures for sizing up existing and potential conditions
    (a) Scope, magnitude, and nature of the incident
    (b) Location, number, and condition of victims
    (c) Risk/benefit analysis (body recovery versus rescue)
    (d) Access to the scene
    (e) Environmental factors
    (f) Available/necessary resources
    (g) Establishment of control perimeter
(2) Procedures for protecting personnel from hazards within the confined space
    (a) Personal protective equipment (PPE)
    (b) Fall protection
    (c) Harnesses
    (d) Lockout/tagout procedures
    (e) Hazard assessment
    (f) Scene assessment
(3) Procedures for ensuring that personnel are capable of appropriately managing the physical and psychological challenges that affect rescuers entering confined spaces
    (a) The AHJ should address the possibility of members of the organization having physical and/or psychological disorders (e.g., physical disabilities, fear of heights, fear of enclosed spaces) that could impair their ability to perform rescue in confined spaces.
(4) Procedures for duties of the rescue entrant(s) and backup rescue entrant(s), rescue attendant, and rescue team leader
(5) Procedures for monitoring confined space atmospheres
    (a) Selection and use of appropriate monitoring equipment
    (b) Monitoring continuously or at frequent intervals
    (c) Establishing order of monitoring
    (d) Setting exposure limits
(6) Procedures for qualifying characteristics for performing entry-type rescues at the operational level
(7) Procedures for using victim packaging devices that could be employed in confined space rescue
(8) Procedures for transferring victim information
(9) Procedures for planning and implementing a confined space rescue operation

(10) Procedures for selecting, constructing, and using a rope lowering and raising system in the high-angle environment

III. TECHNICIAN LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and techniques necessary to operate and supervise a confined space rescue incident.

B. PREREQUISITES: Meet all operations-level requirements

C. CONTENT:

(1) Procedures for evaluating existing and potential conditions
(2) Procedures for medical surveillance program
(3) Procedures for planning entry-type confined space rescues in hazardous environments
(4) Procedures for implementing of the planned response

D.4 Vehicle and Machinery Rescue — Course Outline.

I. AWARENESS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of recognizing conditions requiring technical rescue from vehicles or machinery.

B. PREREQUISITES: None

C. CONTENT:

(1) Three-tiered concepts (awareness, operations, technician) of NFPA 1670 and NFPA 1006, *Standard for Rescue Technician Professional Qualifications*, describing the operational capability of organizations and individuals
(2) Situations/conditions requiring vehicle or machinery rescue
(3) Resources necessary to conduct vehicle or machinery rescue operations
(4) Initiation of emergency response system for vehicle or machinery rescue
(5) Initiation of site control and scene management for vehicle or machinery rescue
(6) General hazards associated with vehicle or machinery rescue
    (a) Utilities
    (b) Hazardous materials
    (c) Personal hazards
    (d) Movement of vehicle(s) or machinery
    (e) Release of high pressure
    (f) Other hazards associated with vehicle or machinery incidents
(7) Initiation of traffic control

II. OPERATIONS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and the techniques necessary to operate at vehicle or machinery rescue incidents.

B. PREREQUISITES: Meet all awareness-level requirements

C. CONTENT:

(1) How to size up existing and potential conditions requiring vehicle or machinery rescue
(2) How to identify probable victim location and survivability
(3) How to make the rescue area safe
    (a) Stabilization
    (b) Isolation
(4) How to identify, contain, and stop fuel release
(5) How to protect/package a victim
(6) How to access trapped victims
(7) How to perform extrication and disentanglement using hand tools

III. TECHNICIAN LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and techniques necessary to operate and supervise a vehicle or machinery rescue incident.

B. PREREQUISITES: Meet all operations-level requirements

C. CONTENT:

(1) Evaluation of existing and potential conditions

(2) Performance of extrication and disentanglement operations

- (a) Frame and construction features of heavy/large vehicles and machinery
- (b) Use and components of a rescue chain assembly
- (c) Pneumatic high-, medium-, and low-pressure lifting bags
- (d) Use, care, and maintenance of wire rope and its associated equipment
- (e) Large and heavy object weight estimation
- (f) Steps necessary to lift and/or move large objects
- (g) Use of commercial heavy wreckers and recovery services to assist at incidents involving large transportation vehicles
- (h) Use, care, and maintenance of both manual and power winches
- (i) Types and examples of lifting devices that use mechanical advantage principles
- (j) Proper and effective use of power tools, including hydraulic, pneumatic, and electrical spreading, cutting, lifting, and ram-type tools
- (k) Disentanglement through both primary and secondary access points through the use of available power tools
- (l) Protection of the victim during this type of extrication or disentanglement operation
- (m) Lockout/tagout of machinery
- (n) Identification and use of various sling configurations

(3) Advanced stabilization of unusual vehicle or machinery rescue situations

(4) Use of all specialized rescue equipment immediately available and in use by the organization

D.5 Wilderness Search and Rescue — Course Outline.

I. AWARENESS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of recognizing a wilderness environment and its potential hazards and contacting the appropriate authorities to effect a search and/or rescue.

B. PREREQUISITES: None

C. CONTENT:

(1) Define “wilderness” and recognize a wilderness environment

(2) Three-tiered concepts (awareness, operations, technician) of NFPA 1670 and NFPA 1006, *Standard for Rescue Technician Professional Qualifications*, describing the operational capability of organizations and individuals

(3) General hazards related to a wilderness environment and the various potential terrains commonly found within a wilderness environment

(4) General limitations of conventional, nonwilderness methods in a wilderness environment

(5) Importance of operating within developed standard operating procedures

(6) Using local response plans

(7) Incident management fundamentals

(8) Initiating the collection and recording of subject, search, and incident information

(9) Isolating any reporting parties or witnesses necessary to assist search personnel

II. OPERATIONS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of safely supporting operations in the wilderness environment in which the rescuer might be required to operate.

B. PREREQUISITES: Meet all awareness-level requirements

C. CONTENT:

(1) General hazards associated with rope rescue
(2) Requesting rope rescue resources
(3) Personal protective equipment used in rope rescue and wilderness operations
(4) Initial size-up (wilderness search and rescue, and low- or high-angle rope rescue techniques)
(5) Low or high rope rescue skills
  (a) Knots, bends, or hitches
  (b) Selecting and using belays and anchors, including single- and multipoint load-sharing anchor systems
  (c) Ascending and descending fixed ropes
  (d) Escaping from dysfunctional ascent and descent control devices
  (e) Selecting and using rope-based mechanical advantage, lowering, and raising systems
  (f) Securing and safely moving a patient in a litter
  (g) Attaching a litter to a rope rescue system
  (h) Serving as a litter attendant in high- and low-angle rope rescue operations
(6) Limitations of an operations-level (versus technician-level) organization in both wilderness and rope rescue disciplines
(7) Requesting wilderness search and rescue and rope rescue resources such as specialty and technician-level teams
(8) The National SAR Plan and its use
(9) Procuring specific materials (e.g., maps, forms, weather forecasts)
(10) Wilderness medical care
(11) Fundamentals of survival
(12) Packing for search and rescue operations: survival and safety equipment
(13) Dressing for the wilderness environment(s): personal environment protection
(14) Navigating accurately within the wilderness environment
(15) Determining urgency and distinguishing a *rescue* from a *recovery*
(16) Operating safely as a searcher and rescuer
(17) Identifying, using, and maintaining rescue equipment
(18) Identifying, using, and maintaining rescue vehicles, including aircraft, watercraft, and specialty vehicles
(19) Collecting and fully recording all subject, search, and incident information

III. TECHNICIAN LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of safely performing, supporting, coordinating, and managing a search and rescue in any wilderness environment in which the rescuer might be required to operate.

B. PREREQUISITES: Meet all operations-level requirements

C. CONTENT:

(1) Water rescue awareness (e.g., water hazard identification/recognition, risk assessment, implementing an emergency response plan, site control and scene management, incident management fundamentals)
(2) Search management and planning
(3) Managing a multi-operational period incident
(4) Developing standard operating procedures
(5) Wilderness skills and travel
(6) Developing an operational wilderness search and rescue plan
(7) Advanced rope rescue skills
  (a) Rope rescue physics (safety factors, critical angles, force multipliers, etc.)
  (b) Negotiating obstacles while ascending/descending and raising/lowering

(c) Passing knots while ascending/descending and raising/lowering
(d) Difficult edge negotiating
(e) High-line rope systems
(f) Litter attendants within high-line rope systems
(g) Troubleshooting rope rescue systems

D.6 Trench and Excavation Search and Rescue — Course Outline.

I. AWARENESS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of recognizing conditions requiring trench and excavation rescue and making appropriate notifications to begin the rescue process.

B. PREREQUISITES: None

C. CONTENT:

(1) Three-tiered concept (awareness, operations, technician) of NFPA 1670, describing the operational capability of organizations and individuals
(2) Procedures for recognizing the need for a trench and excavation rescue
(3) Procedures for initiating the emergency response system where trench and excavation rescue is required
(4) Procedures for carrying out site control and scene management
(5) Procedures for recognizing general hazards associated with trench and excavation rescue
    (a) Utilities
    (b) Hazardous materials
    (c) Personal hazards
    (d) Confined spaces
(6) Procedures for recognizing typical trench and excavation collapse patterns, the reasons trenches and excavations collapse, and the potential for secondary collapse
    (a) Types of collapse
        i. Spoil pile collapse
        ii. Shearwall collapse
        iii. Slough collapse
    (b) Reasons for collapse and potential for secondary collapse
        i. Unprotected trench (lack of protection systems)
        ii. Static loads
        iii. Standing water or water seeping into trench
        iv. Intersecting trenches
        v. Vibrations (from vehicles, nearby roads, airports, etc.)
        vi. Previously disturbed soil
        vii. Exterior cracking of trench walls
(7) Procedures for making a rapid, nonentry extrication of noninjured or minimally injured victim(s)
(8) Procedures for recognizing the unique hazards associated with the weight of soil and its associated entrapping characteristics

II. OPERATIONS LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and the techniques necessary to operate at trench and excavation rescue incidents.

B. PREREQUISITES: Meet all awareness-level requirements

C. CONTENT:

(1) Procedures for sizing up existing and potential conditions
    (a) Scope, magnitude, and nature of the incident
    (b) Location, number, and condition of victims
    (c) Risk/benefit analysis (body recovery versus rescue)

(d) Exposure to traffic and sources of vibration
(e) Hazards
i. Disrupted or exposed utilities
ii. Standing or flowing water
iii. Secondary collapse
iv. Mechanical hazards
v. Presence of hazardous materials
vi. Explosives
(f) Trench/excavation dimensions
(g) Environmental factors
(h) Available/necessary resources

(2) Procedures for initiating entry into a trench or excavation rescue area

(3) Procedures for recognizing unstable areas associated with trench and excavation emergencies and adjacent structures
(a) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning should be provided to ensure the stability of such structures for the protection of employees. Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees should not be permitted except when one of the following occurs:
i. A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure.
ii. The excavation is in stable rock.
iii. A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity.
iv. A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees. Sidewalks, pavements, and appurtenant structures should not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(4) Procedures for identifying probable victim locations and survivability
(a) Visualization of the victim
(b) Presence of drink cups or food containers, work tools, laser targets, buckets, grade poles, grease and brush, engineers' hubs, or anything that can indicate the victim's last probable physical location
(c) Information from bystanders
(d) End of pipe string
(e) Sounds in pipes
(f) “Cat” or tire tracks

(5) Procedures for making the rescue area safe
(a) Utilizing sheeting and shoring to stabilize trench/excavation walls
(b) Safely undertaking disentanglement operations in the trench/excavation
(c) Placing ground pads at the lip of the trench/excavation
(d) Ventilating the trench and monitoring its atmosphere
(e) Dewatering
(f) Supporting any unbroken utilities
(g) Providing appropriate personal protective equipment for a victim
(h) Prohibiting entry into an unsafe trench/excavation
(i) Preventing the touching or operating of heavy equipment until its safety has been established

(6) Procedures for initiating a one-call utility location service

(7) Procedures for identifying soil types using accepted visual or manual tests
   (a) Cemented soil
   (b) Cohesive soil
   (c) Dry soil
   (d) Fissured soil
   (e) Granular soil
   (f) Layered system
   (g) Moist soil
   (h) Plastic
   (i) Saturated soil
   (j) Stable rock
(8) Procedures for ventilating the trench or excavation space
(9) Procedures for identifying and recognizing a bell-bottom excavation (pier hole) and its associated unique hazards
(10) Procedures for placing ground pads and protecting the "lip" of a trench or excavation
(11) Procedures for providing entry and egress paths for entry personnel
   (a) A ladder or engineered ramp can be required for entry or egress from a trench. A stairway, ladder, ramp, or other safe means of egress should be located in trench excavations that are 4 ft or more in depth so as to require no more than 25 ft of lateral travel for employees
(12) Procedures for conducting a pre-entry briefing
   (a) Tactical assignments with explicit instructions
   (b) General hazards and safety instructions
   (c) Communications protocols, procedures, and details
   (d) Anticipated environmental concerns
   (e) Time frames for operations
   (f) Emergency procedures
   (g) Specific equipment needs
   (h) Debriefing procedures
(13) Procedures for initiating record-keeping and documentation during entry operations
   (a) Development of some type of representation of IMS command structure
   (b) Time of incident
   (c) Total time of operation
   (d) Environmental conditions
   (e) Location of victim
   (f) Creation of a tactical checklist that includes the following:
      i. Entry/exit times
      ii. Personal accountability reports
      iii. Atmospheric readings
      iv. Rehabilitation information
      v. Injuries sustained
      vi. Incident number
(14) Procedures for selection, utilization, and application of shield systems
(15) Procedures for selection, utilization, and application of sloping and benching systems
(16) Procedures for assessing the mechanism of entrapment and the appropriate method of victim removal
(17) Procedures for performing extrication
   (a) Hand digging

(b) Lifting using air bags, pneumatic, or other mechanical advantage devices
(c) Suctioning
(d) Cutting using air knives, saws, or other power tools
(e) Dewatering
(f) Using heavy equipment

III. TECHNICIAN LEVEL

A. OBJECTIVE: At the completion of this training, the student should be capable of hazard recognition, equipment use, and techniques necessary to operate and supervise a trench and excavation rescue incident.

B. PREREQUISITES: Meet all operations-level requirements

C. CONTENT:

(1) Procedures for evaluating existing and potential conditions
(2) Procedures for the identification, construction, application, limitations, and removal of manufactured protective systems using tabulated data and approved engineering practices
(3) Procedures for monitoring the atmosphere in all parts of the trench
    (a) Selection and use of appropriate monitoring equipment
    (b) Order of monitoring
    (c) Exposure limits
(4) Procedures for identification, construction, application, limitations, and removal of supplemental sheeting and shoring systems designed to create approved protective systems
(5) Procedures for adjusting the protective systems based on digging operations and environmental conditions
(6) Procedures for rigging and placing of isolation systems

Annex E External Resources

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1

The research and documentation of available external resources that can augment its internal capabilities form a crucial component in the overall ability of the AHJ to respond and operate at technical rescue incidents.

Due to the potential complexity of related technical search and rescue incidents and the variety of conditions and factors that can exist at site-specific or large-scale incidents, external resource allocation and deployment becomes necessary to support the search and rescue function. The AHJ can develop a comprehensive list of resources that can aid the responding agency by first using the hazard identification and risk assessment evaluation to identify those factors that currently can limit its overall response capability. Once limitations or resource deficiencies are identified, the AHJ can develop a resource database by reviewing those firms or businesses that are located within the jurisdiction. The telephone directory for the jurisdiction is an excellent reference that provides general categories and listing headings for companies, firms, and agencies that can become sources for resource allocation.

The identification of area needs can be associated with the following four general categories, though there may be others:

(1) Technical services
(2) Equipment
(3) Supplies
(4) Services

In addition, the AHJ should identify and contact local professional societies, associations, and trade groups, which can become excellent sources for technical support and resource development. Such professional groups include the following:

(1) American Institute of Architects (AIA)
(2) American Society of Consulting Engineers (ASCE)
(3) Association of Building Contractors (ABC)
(4) Local or regional builders exchange
(5) Construction Specification Institute (CSI)
(6) American Society of Safety Engineers (ASSE)
(7) American Public Works Association (APWA)
(8) Association of General Contractors (AGC)
(9) International Association of Bridge, Structural and Ornamental Iron Workers
(10) National Association of Demolition Contractors

The development of a community resource directory based on these contacts documents and makes readily available the variety of resources that might be needed in the event of a technical rescue incident. The community resource directory should include information on each firm, company, or agency appearing in the directory. A profile of the specialized resource(s) available, along with contact person(s) information, including telephone numbers for both home and work, also should be included.

Although the compiled data can be entered and stored on a computer database, a binder or book-formatted system should be used to adapt easily for field use. The use of laptop computer notebooks with disk-formatted data can also prove useful, and consideration should be given to the longevity and portability provided by battery packs.

A Memorandum of Agreement (MOA) should be developed that outlines specifications for equipment and resource allocation, availability of services and procedures for procurement, and subsequent financial reimbursement for services or equipment supplied.

In addition to the types of resources previously identified, the AHJ also should consider the development of a resource guide for the procurement of technical services from individuals associated with specific groups or agencies. This resource guide could include profiles of personnel, such as canine handlers with search dogs, technical rescue specialists, industrial hygienists, riggers, and so forth, who, on an on-call basis, could respond and augment on-scene resources.

The AHJ should not disregard resource acquisition requests to agencies and groups outside the immediate boundaries of the jurisdiction. Regional, statewide, and national resources could be identified based on the overall projected needs determined through the hazard identification and risk assessment.

Depending on the size and magnitude of the incident, resource availability might not be adequate to meet incident logistical needs, or the resources might be affected by whatever caused the incident, especially where a large area within the jurisdiction is part of the overall incident conditions. Such could be the case in an earthquake, hurricane, flooding, or other large-scale natural disaster.

Regional, multistate, or national deployment of specialized rescue teams or task forces should be considered in the development of the overall resource directory to provide additional capabilities as incident conditions and incident magnitude necessitate.

Annex F Hazards Found in Structural Collapse

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

F.1

General hazards associated with search and rescue operations at structural collapses can present the AHJ with uniquely challenging situations. The AHJ should consider the following potential hazards when providing training to its members:

(1) *Utilities.* Control of the utilities in and around a structural collapse is critical to ensure the safety of responding personnel and victims. The AHJ should provide its members with training in the control of these services to provide a safe environment in which to operate and to ensure the safety of victims. The following utilities should be considered when providing training:
   (a) Electrical services (primary and secondary)
   (b) Gas, propane, fuel oil, or other alternative energy sources (primary systems)
   (c) Water
   (d) Sanitary systems
   (e) Communications
   (f) Secondary service systems (i.e., compressed, medical, or industrial gases)

(2) *Hazardous Materials.* Collapsed structures might include various materials unique to an occupancy that, when released during a structural collapse, could pose a hazard to victims and responders. The AHJ should provide members with training in the recognition of potential hazardous materials releases, the determination of an existing hazard, and the methods used to contain, confine, or divert hazardous materials to conduct operations safely and effectively.

(3) *Personal Hazards.* At the site of any structural collapse, there are many dangers that pose personal injury hazards to the responders. The AHJ should train members to recognize the personal hazards they encounter and to use the methods needed to mitigate these hazards to help ensure their safety. Every member should be made aware of hazards such as trips, falls, blows, punctures, impalement, and so forth.

(4) *Confined Space.* Some structural collapses necessitate a confined space rescue. Responding personnel should be familiar with and trained in confined space rescue requirements and techniques. The AHJ should determine the applicable laws and standards related to confined space rescue and should provide members with training in confined space rescue.

(5) *Other Hazards.* There are numerous other hazards associated with structural collapses. The AHJ should make every effort to identify the hazards that might be encountered within the jurisdiction and should provide members with training and awareness of these other hazards to allow them to perform rescue operations safely and effectively.

Hazard recognition training should include the following as a minimum:

(1) Recognition of building materials and structural components associated with light-frame ordinary construction
(2) Recognition of unstable collapse and failure zones of light-frame ordinary construction
(3) Recognition of collapse patterns and probable victim locations associated with light-frame ordinary construction

F.2 Four Categories of Building Construction.

The construction categories, types, and occupancy usage of various structures might necessitate the utilization of a variety of different techniques and material. The four construction categories that the rescuer most likely will encounter in collapse situations are light-frame, heavy wall, heavy floor, and precast concrete construction. The following four categories usually comprise the majority of structures affected by a collapse:

(1) *Light-Frame Construction.*
   (a) Materials used for light-frame construction are generally lightweight and provide a high degree of structural flexibility in response to forces such as earthquakes, hurricanes, tornados, and so forth.

(b) These structures typically are constructed with skeletal structural frame systems of wood or light-gauge steel components that provide support to the floor and roof assemblies.

(c) Examples of this construction type include wood frame structures used for residential, multiple low-rise, and light commercial occupancies up to four stories in height. Light-gauge steel frame buildings include commercial, business, and light manufacturing occupancies and facilities.

(2) *Heavy Wall Construction.*

(a) Materials used for heavy wall construction are generally heavy and utilize an interdependent structural or monolithic system. These types of materials and their assemblies tend to produce a structural system that is inherently rigid.

(b) This construction type usually is built without a skeletal structural frame. It utilizes a heavy wall support and assembly system that provides support for the floors and roof areas.

(c) Occupancies utilizing tilt-up concrete construction are typically one to three stories in height and consist of multiple, monolithic concrete wall panel assemblies. They also use an interdependent girder, column, and beam system for providing lateral wall support of floor and roof assemblies. Such occupancies typically include commercial, mercantile, and industrial usage. Materials other than concrete now are being utilized in tilt-up construction.

(d) Examples of this type of construction include reinforced and unreinforced masonry buildings typically of low-rise construction, one to six stories in height, and of any occupancy type.

(3) *Heavy Floor Construction.*

(a) Structures of heavy floor construction are built utilizing cast-in-place concrete construction consisting of flat slab panel, waffle, or two-way concrete slab assemblies. Pretensioned or post-tensioned reinforcing steel rebar or cable systems are common components used for structural integrity. The vertical structural supports include integrated concrete columns, concrete-enclosed steel frame, or steel frame, which carry the load of all floor and roof assemblies. This type of structure includes heavy timber construction that might use steel rods for reinforcement.

(b) The reinforcing steel, along with the varying thicknesses of concrete structural slab and girder supports utilized in this construction assembly, pose significant concerns with respect to breaching and void penetration.

(c) The loss of reinforcement capability and the integrity of structural loading capacity of the floor and wall assemblies create significant safety and operational considerations during collapse operations.

(d) Structural steel frame construction utilizes a skeletal framing system consisting of large-load-carrying girders, beams, and columns for structural support. These components represent a substantial weight factor for individual and assembly components. Floor systems consist of cast-in-place concrete slabs of varying thicknesses poured onto metal pan or structural metal floor decks and also might include precast and post-tensioned concrete plank systems. These concrete/metal pan floor assemblies are supported by the structural steel framing system.

(e) The exterior construction might consist of metal or masonry veneer, curtain wall, or composite material panel systems. Additionally, precast concrete or stoneclad panel systems might be present.

(f) Multiple assembly or component failures might be present in a collapse situation where isolated or multiple collapse conditions or collapse configurations exist.

(g) Examples of this type of construction include offices, schools, apartments, hospitals, parking structures, and multipurpose facilities. Heights vary from single-story to high-rise structures.

(4) *Precast Construction.*

(a) Structures of precast construction are built utilizing modular precast concrete components that include floors, walls, columns, and other subcomponents that are field-connected at the site.

(b) Individual concrete components utilize imbedded steel reinforcing rods and welded wire mesh for structural integrity and might utilize either steel beam and column or concrete framing systems for the overall structural assembly and building enclosure.

(c) These structures rely on single or multipoint connections for floor and wall enclosure assembly and are a safety and operational concern during collapse operations.

(d) Examples of this type of construction include commercial, mercantile, office, and multiuse or multifunction structures, including parking structures and large occupancy facilities.

Table F.2 lists the four model construction codes and standards commonly adopted within the United States and is provided to aid the AHJ in identifying the relationship of NFPA 1670 construction/collapse types to their applicable code. These model codes are referenced to classification Types I through V as specified in NFPA 220, *Standard on Types of Building Construction*, *Standard on Types of Building Construction.*

Table F.2 Fire-Resistive Building Types

Reference	Fire-Resistive[1]		Noncombustible[1]			Ordinary[1]		Heavy Timber[1]	Wood[1]	
NFPA 220[2,3]	Type I		Type II			Type III		Type IV	Type V	
	443	332	222	111	000	211	200	2HH	111	000
BOCA[4]	Type I		Type II			Type III		Type IV	Type V	
	1A	1B	2A	2B	2C	3A	3B	4	5A	5B
UBC[5]	Type I		Type II			Type III		Type IV	Type V	
	P		P	P	NP	P	NP		P	NP
SBC[6]	Type I	Type II	Type IV			Type V		Type III	Type VI	
	433	332	P	NP	P	NP	2HH	P	NP	

[1]The table headings for fire-resistive, noncombustible, ordinary, heavy timber, and wood construction do not represent any special construction code classification but are meant to provide an easily recognizable general construction type reference.
[2]See NFPA 220, *Standard on Types of Building Construction,* for common definitions of construction Types I through V.
[3]The three-digit arabic numbers that appear beneath each construction type heading designate the fire resistance rating requirements for certain structural elements specified in NFPA 220, *Standard on Types of Building Construction.* They are provided in this table as a reference and to indicate their relationship to each type of construction.
[4]Construction types are referenced to the BOCA *National Building Code* for correlation with fire-resistive rating requirements for each construction type.
[5]Construction types are referenced to UBC, *Uniform Building Code.* The designations P and NP stand for “protected” and “not protected,” respectively, as used within the UBC.
[6]Construction types are referenced to SBC, *Standard Building Code.* The designations P (protected) and NP (not protected) are used in order to provide correlation with *Uniform Building Code* information.

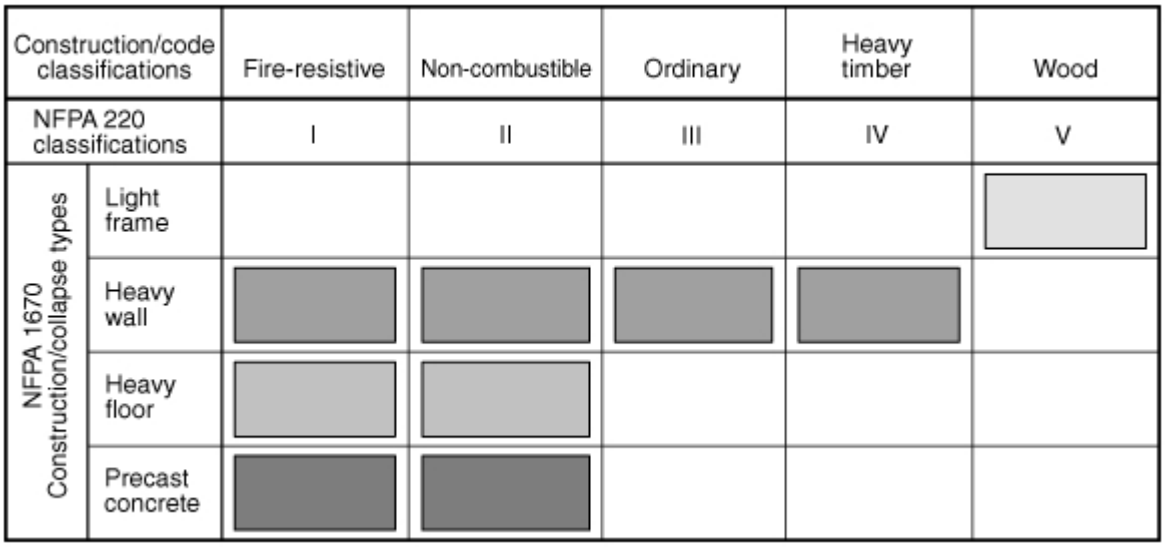


FIGURE F.2 Construction Code Classifications by Building Type.

Figure F.2 is intended to identify construction/collapse types according to the classifications of NFPA 220, *Standard on Types of Building Construction*, 1999 edition., and is not part of any fire-resistive or fire rating/assembly requirement. In this table, the NFPA 1670 construction/collapse types are referenced to NFPA 220 to allow rapid correlation of construction code classification with the associated construction/collapse type. Depending on occupancy, usage, and actual size of the structure, some construction code classifications can exhibit characteristics of other than specifically correlated construction/collapse types.

Annex G Structural Hazard Evaluation

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

G.1

Structure/hazards evaluation and search assessment procedures are designed to identify specific information pertinent to each affected building. Either of these analyses can be completed independently of the other, although the structure/hazards evaluation normally is completed first. Symbols should be drawn conspicuously with orange spray paint. *(See FEMA US&R Response System, Appendix C, "Task Force Building Marking System.")*

One of the initial strategic concerns for personnel is the need to analyze the structure(s) involved in any collapse situation. This is especially true where there is more than one structure involved, as in cases of devastating earthquakes, hurricanes, or other natural or man-made disasters. The determination of the condition of the structure, hazards, and occupancy prior to the event will affect the overall search and rescue strategy.

It is imperative that the information derived from a coordinated building triage and marking system be consolidated by the AHJ at any structural collapse event. This information not only should be used to identify operational priorities but also should be forwarded to the incident commander to assist in the overall assessment of the event.

G.2 FEMA Task Force Search and Rescue Marking System.

Distinct markings should be made within the four quadrants of an "X" to denote clearly the search status and findings during the search. Figure G.2 illustrates the search marking system.

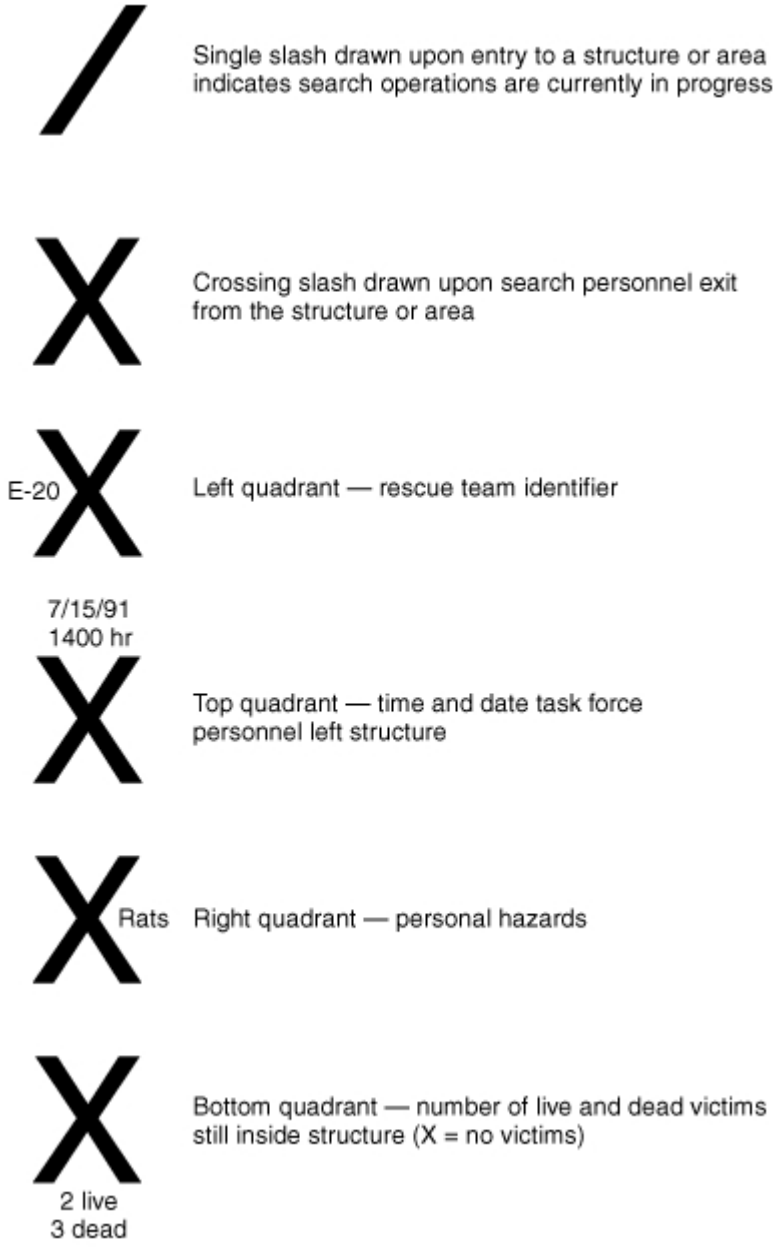


FIGURE G.2 FEMA Task Force Search and Rescue Marking System.

An "X" measuring 0.6 m ×0.6 m (2 ft ×2 ft) should be spray-painted in the color orange. The information for each quadrant should be written in the quadrant using carpenter's chalk or a lumber crayon.

In addition, search personnel should mark the exact location of a victim(s) with orange spray paint. Surveyor's tape can be used as a flag to identify the appropriate area in conjunction with the spray paint. To reduce needless duplication of search efforts, markings should be made at each point of entry or separate area of the structure. Where updated information of previously searched structures is needed, the old information should be crossed out and the most recent information should be indicated below or next to the old, using the marking system.

G.3 FEMA Task Force Building Marking System (Structure/Hazard Evaluation).

This system is designed to identify specific hazards associated with any collapsed structure. Personnel should be cognizant of the nationally accepted marking system and should be proficient in the use of the system. *(See FEMA US&R Response System, Appendix D, "Structure Triage, Assessment & Marking System.")*

After performing a building hazard identification, the responder uses international orange spray paint to make a 0.6 m ×0.6 m (2 ft ×2 ft) square box on the building adjacent to the most accessible point of entry. Figure G.3 illustrates the search marking system.

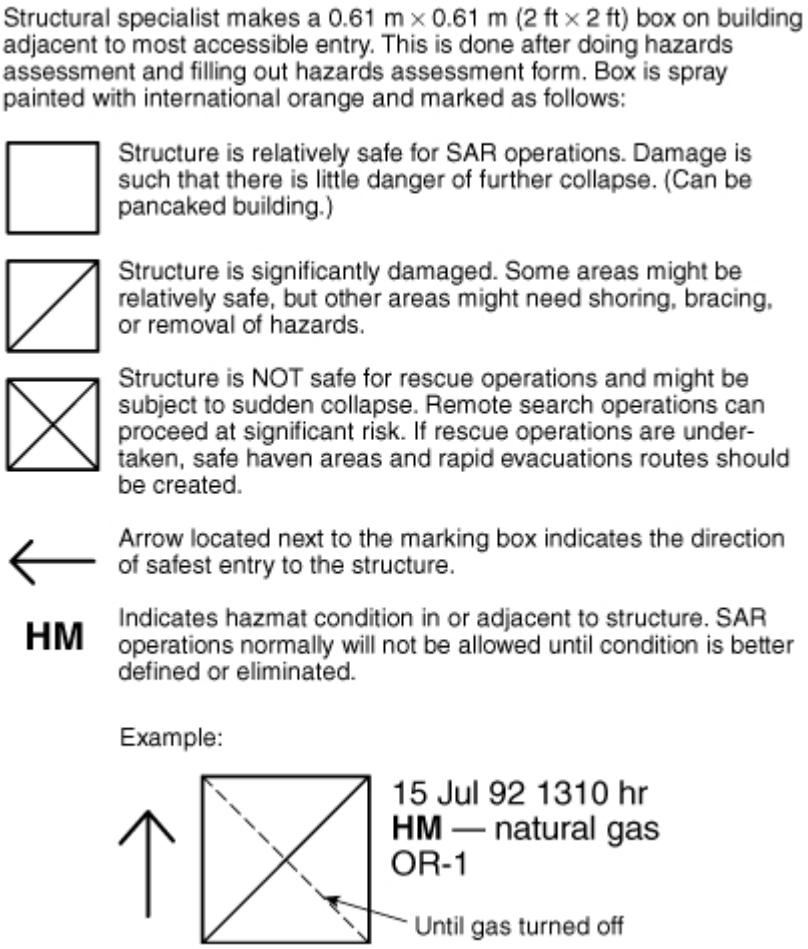


FIGURE G.3 Task Force Building Marking System Structure/Hazard Evaluation.

An empty box indicates that the building is relatively safe for search and rescue operations and that damage is such that there is little danger of further collapse. One diagonal line in the box indicates that the structure is significantly damaged and that some areas may need shoring, bracing, or removal of hazards in spite of the fact that some areas may be safe. Two diagonal lines in the box (an "X") indicate that the building is not safe for search and rescue operations and might be subject to sudden collapse. An arrow next to the marking box indicates the direction of safest entry to the structure. To the right of the marking box, text is used to indicate the time and date of the search, the team designation, and hazard(s) found. The letters HM to the right of the box (in the text area) indicate a hazmat condition in or adjacent to the structure. When HM is used, search and rescue operations normally will not be allowed until the condition is better defined or eliminated.

G.4 FEMA Task Force Structure Marking System (Structure Identification within a Geographical Area).

Structure identification within a geographic area is used to differentiate buildings by groups, such as by block(s) or jurisdictional area. This geographic area identification should be consolidated at the command post of the AHJ and used to deploy search and rescue personnel. *[See Figure G.4(a).]*

International orange spray paint is used to mark buildings with their street number so that personnel can differentiate one building from another. Existing numbers should be used to fill in any unknown numbers. If all numbers are unknown, arbitrary numbers can be used (odd and even used on opposite sides of the street). The primary method of identification should include the existing street name, hundred block, and building number. Such identification is not always possible due to postdisaster conditions. *(See FEMA US&R Response System, Appendix D, "Structure Triage, Assessment & Marking System.")*

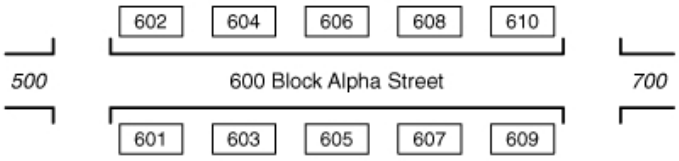
An important duty of a structure triage team is to clearly differentiate buildings in groupings such as by block(s) or jurisdictional areas/sectors. This geographic (area/sector) identification of buildings would be consolidated at the command post and used to deploy search and rescue personnel and/or track structure/hazard evaluation and search assessment information.

It is imperative that each structure within a geographic area is clearly defined. This identification will assist both in the specific ongoing search and rescue effort and in the long-term post-disaster identification of the site. This identification is important from a technical documentation perspective regarding the specific events that took place at a given site. Structure identification has a significant impact on overall scene safety and the safety of task force personnel.

It is important to clearly identify each separate structure within a geographic area when information is being disseminated to other operational entities. The primary method of identification should be the existing street name, hundred block, and building number. Obviously, such identification is not always possible due to post-disaster site conditions. In these situations, it is important that the task force personnel implement the following system for structure identification.

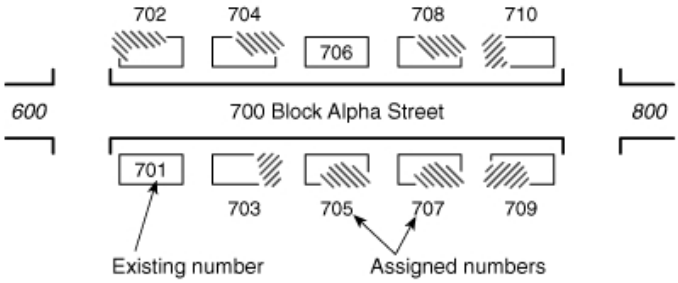
This system builds upon the normal pre-disaster street name, hundred block, and building number. As task force personnel establish a need to identify a structure within a given block they will do the following:

1. Each structure should be identified by existing street name and building number.

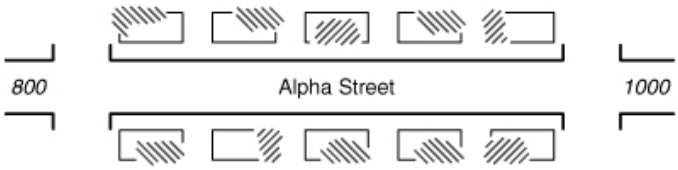


2. If some previously existing numbers have been obliterated, an attempt should be made to re-establish the numbering system based upon one or more structures that still display an existing number.

3. The damaged building(s) would be assigned numbers to separately identify them as indicated. The front of the structure(s) in question should be clearly marked with the new numbers being assigned using international orange spray paint.



4. If no number is identifiable in a given block then task force personnel will identify the street name and the hundred block for the area in question on other structures in proximity to the site in question.



5. In this case, structures will be assigned the appropriate numbers to designate and differentiate them. The front of the structure(s) in question should be clearly marked with the new number being assigned using international orange spray paint.

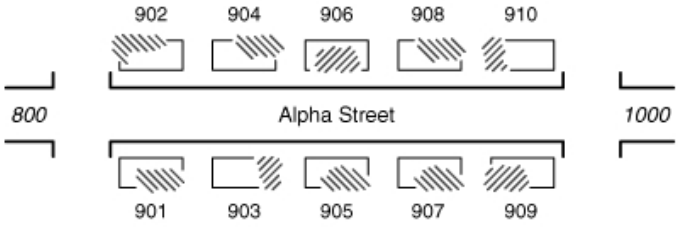


FIGURE G.4(a) Task Force Structure Marking System Structure Identification Within a Geographic Area.

A standard approach to describing each building's layout is also used. The street side of the building is side 1. Subsequent sides (2, 3, 4) are labeled in a clockwise direction around the building. Internally, quadrants are described starting with the front left corner (while standing at the front, street side of the building) and labeled with letters starting with "A." Subsequent quadrants (B, C, D) are labeled in a clockwise direction around the interior of the building, with the core (center) being labeled "E." Stories are labeled 1, 2, 3, and so forth, and basements are designated B1, B2, B3, and so forth.

It is imperative that personnel clearly identify each structure within a geographic area. This identification will assist both in the specific ongoing search and rescue effort and the long-term, postdisaster identification of the site. *[See Figure G.4(b).]*

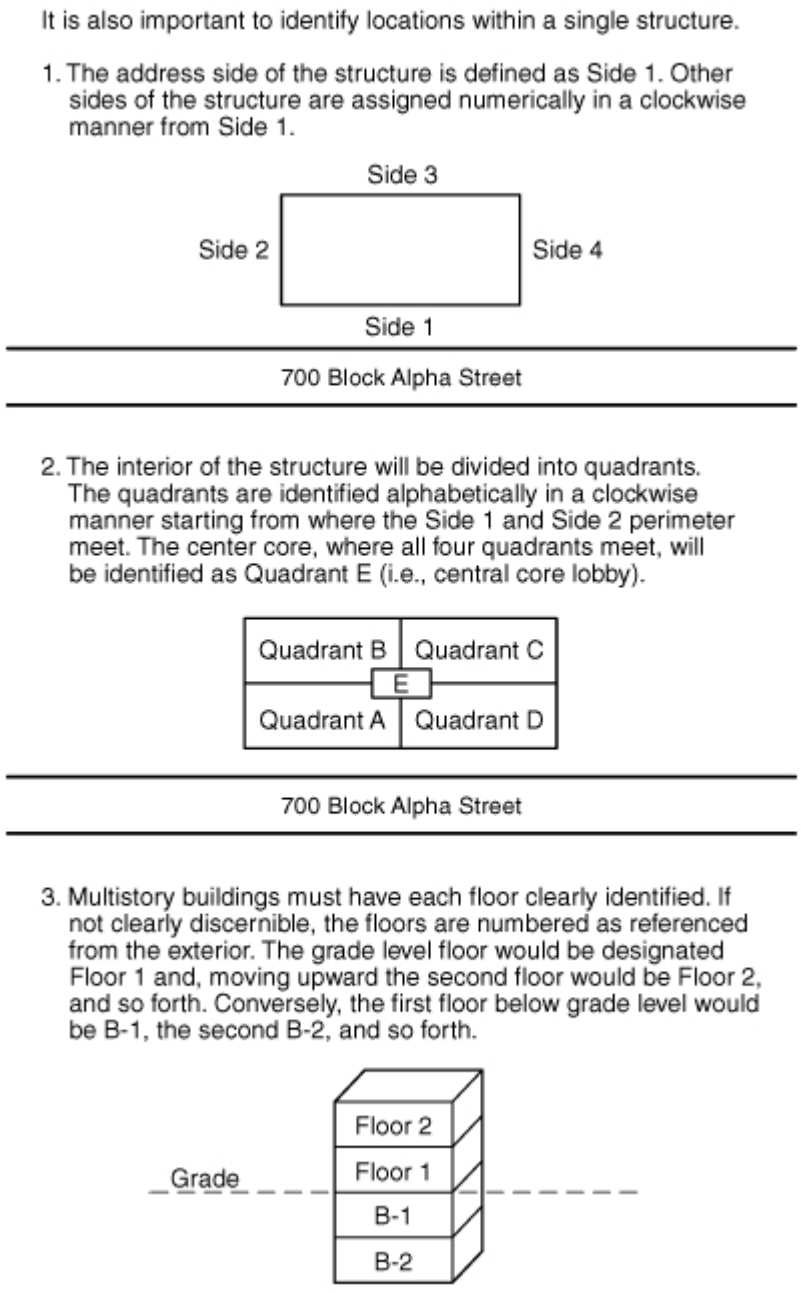


FIGURE G.4(b) Task Force Structure Marking System Structure Identification Within a Geographic Area — Single Structure.

G.5 Victim Location Marking System.

During the search function, it is often necessary to identify the location of potential and known victims because debris in the area may completely cover, obstruct, or hide the location of any victims. When a known or potential victim is located and not removed immediately, victim location marking symbols are made by the search team or others aiding the search and rescue operation. These symbols should be made with orange spray paint or orange crayon.

Figure G.5(a) through Figure G.5(f) illustrate examples of the marking system in use, described as follows:

(1) Initially, a large [approximately 2 ft (0.6 m) across] "V" is painted near the location of the known or potential victim.

(2) If the victim's location is not clearly visible or if the victim is some distance from the symbol, an arrow can be added next to the "V" pointing toward the location of the victim.

(3) The US&R Task Force identifier is placed in the open part of the "V".

(4) A circle is placed 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.

(5) Confirmation can be done when the victim is initially located, after partial debris removal, or with the use of specialized search equipment such as video or fiber-optic cameras.

(6) 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.

(7) A horizontal line is painted through the middle of the "V" when the victim is confirmed to be deceased.

(8) An "X" is painted through the confirmed victim symbol after all victims have been removed from the specific location identified by the marking.

(9) New victim symbols are painted next to additional victims that are located later, near where the original victim(s) were removed (assuming the original symbol has been "X"ed out).

(10) 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.

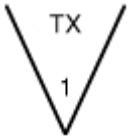


FIGURE G.5(a) An Example Indicating a Potential Victim.

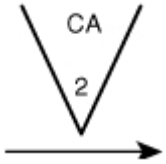


FIGURE G.5(b) An Example Indicating a Potential Victim in the Direction of the Arrow.

FIGURE G.5(c) An Example Indicating a Confirmed Live Victim.

FIGURE G.5(d) An Example Indicating a Confirmed Deceased Victim.

FIGURE G.5(e) An Example Indicating the Removal of a Confirmed Live Victim.

FIGURE G.5(f) An Example Indicating the Removal of a Confirmed Deceased Victim.

Annex H Classification of Spaces by Types

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

H.1

Specific procedures for mitigating hazards at confined space rescue can include, but are certainly not limited to, consideration of the following:

(1) Personal protective equipment (PPE)
(2) Fall protection
(3) Harnesses
(4) Lockout/tagout procedures
(5) Hazard identification
(6) Scene assessment

Procedures to perform a confined space hazard identification include, but are not limited to, the following:

(1) Identification of the important industrial documentation, where available, useful in hazard identification; This includes entry permits, lockout/tagout procedures and checklists, and hot work permits.
(2) Selection of all applicable information necessary for emergency responders from a material safety data sheet (MSDS)
(3) PPE for the hazard as per NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, and OSHA regulations in 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER)

Procedures to perform a scene assessment to determine the magnitude of the problem in terms of life safety can include, but are not limited to, the following:

(1) The type, size, access, and internal configuration of the confined space
(2) Information regarding current and potential hazards that threaten victims and rescuers
(3) A risk/benefit analysis concerning the threat to rescuers in relation to the viability of victims

Figure H.1 shows confined spaces normally found in an industrial setting. Classifying spaces by "types" can be useful in preparing a rescue training plan to include representative permit spaces for practicing rescue operations as specified by OSHA. These types focus mainly on the OSHA-specified criteria of opening size, configuration, and accessibility. Another important factor to consider is the internal configuration (congested or noncongested) of the permit-required confined space. The following are definitions for types of confined spaces normally found in an industrial setting, as shown in Figure H.1:

(1) *Diagonal Portal.* Plane of manway or portal is at an angle (between perpendicular and parallel to the ground). To be considered as a vertical entry/horizontal portal.
(2) *Elevated Portal.* Bottom of passageway is 1.22 m (4 ft) or higher from ground level.
(3) *Horizontal Entry.* Access passageway is entered traveling parallel to ground level through a vertical portal.
(4) *Manway or Portal.* An internal or external opening large enough for a person to pass through.
(5) *Rectangular/Square Portal.* A four-sided opening with four right angles. Opening size is determined by measuring the shortest side of the opening.
(6) *Rounded/Oval Portal.* A circular or elliptical opening; also any polygon not having exactly four sides. Opening size is determined by measuring the smallest inside diameter.
(7) *Vertical Entry.* Access passageway is entered traveling perpendicular to ground level through a horizontal portal.

CS TYPE 1 / 1E — elevated
Portal size: Less than 0.61 m (24 in.)
Configuration: Round / oval
Accessibility: Horizontal entry (vertical portal)

CS TYPE 2 / 2E — elevated
Portal size: 0.61 m (24 in.) or larger
Configuration: Round / oval
Accessibility: Horizontal entry (vertical portal)

CS TYPE 3 / 3E — elevated
Portal size: Less than 0.61 m (24 in.)
Configuration: Square / rectangle
Accessibility: Horizontal entry (vertical portal)

CS TYPE 4 / 4E — elevated
Portal size: 0.61 m (24 in.) or larger
Configuration: Square / rectangle
Accessibility: Horizontal entry (vertical portal)

***CS TYPE 5 / 5E** — elevated
Portal size: Less than 0.61 m (24 in.)
Configuration: Round / oval
Accessibility: Vertical top entry (horizontal portal)

***CS TYPE 6 / 6E** — elevated
Portal size: 0.61 m (24 in.) or larger
Configuration: Round / oval
Accessibility: Vertical top entry (horizontal portal)

***CS TYPE 7 / 7E** — elevated
Portal size: Less than 0.61 m (24 in.)
Configuration: Square / rectangle
Accessibility: Vertical top entry (horizontal portal)

***CS TYPE 8 / 8E** — elevated
Portal size: 0.61 m (24 in.) or larger
Configuration: Square / rectangle
Accessibility: Vertical top entry (horizontal portal)

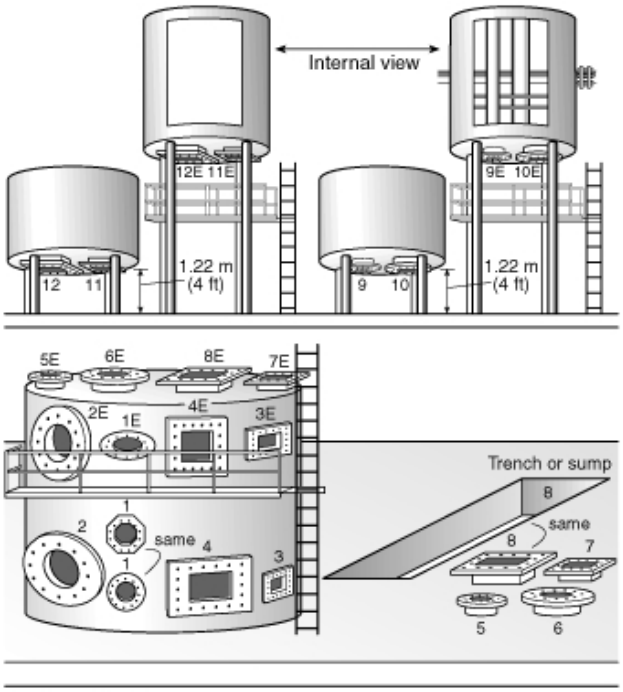
CS TYPE 9 / 9E — elevated
Portal size: Less than 0.61 m (24 in.)
Configuration: Round / oval
Accessibility: Vertical bottom entry (horizontal portal)

CS TYPE 10 / 10E — elevated
Portal size: 0.61 m (24 in.) or larger
Configuration: Round / oval
Accessibility: Vertical bottom entry (horizontal portal)

CS TYPE 11 / 11E — elevated
Portal size: Less than 0.61 m (24 in.)
Configuration: Square / rectangle
Accessibility: Vertical bottom entry (horizontal portal)

CS TYPE 12 / 12E — elevated
Portal size: 0.61 m (24 in.) or larger
Configuration: Square / rectangle
Accessibility: Vertical bottom entry (horizontal portal)

* *Could include open sumps, pits, tanks trenches, and so forth.*



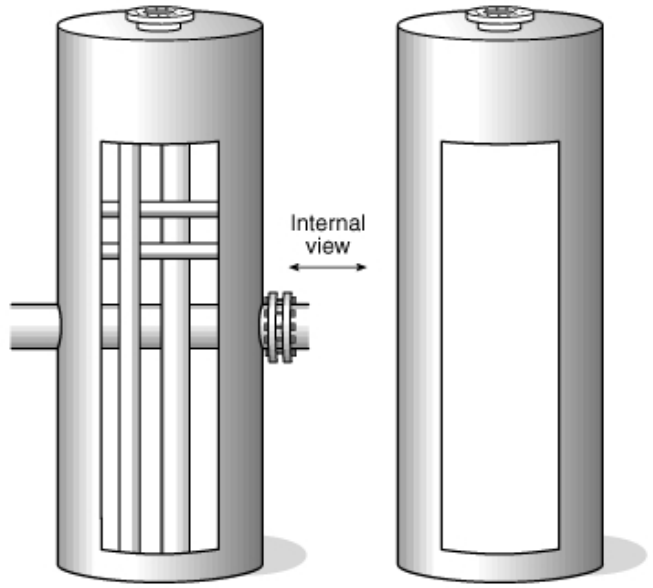


FIGURE H.1 Confined Space Types for Rescue Training Purposes.

Annex I Confined Space Needs Analysis Plan

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

I.1

Guidelines for initial response planning within the quantity and capability of available personnel and equipment should include, but are not limited to, the following:

(1) Response objectives for confined space emergencies
(2) Nonentry rescue options
(3) Entry-type rescue options
(4) Determination of whether rescuer and equipment capabilities are appropriate for available rescue options
(5) Needs analysis and procedures for providing emergency decontamination to victims suspected of being contaminated with a hazardous material *(See Figure I.1.)*

Operational procedures for response implementation should include, but are not limited to, the following:

(1) Scene control procedures including control zones and communication
(2) Incident management system consistent with the organization's standard operating procedure
(3) Nonentry retrieval
(4) Qualifying entry-type rescues
(5) Emergency decontamination as needed
(6) Technical-level rescue service assistance

Confined Space Rescue Preplan

Date:

Space Designation: *(unit / vessel name and ID number)*	**Space Location:**

Staging Area:

Space Category: ❑ Category I — Rescue Available (RA) ❑ Category II — Rescue Stand-by (RS)	**Space Type (1–12):** _____ Elevated: Y N Congested Y N

Means to Summons Rescue Service:
❑ Phone ❑ Pager ❑ Radio ❑ Audible signal ❑ Intercom ❑ Other _____

Method of Rescue: ❑ *Confirm that attendant has been trained in emergency response procedures.*

❑ External (retrieval):	❑ Internal: _____ (congested: _____)
❑ Hauling system required	❑ Victim-lowering system required / lowering area: _____
❑ Anchorage: overhead: _____	Pre-rigging required? ❑ Yes ❑ No

Anchorage: ❑ Beam ❑ Welded steel handrail ❑ Support strut ❑ Other: _____
❑ Stairwell ❑ Anchored steel pipe ❑ Support column

Suggested CSR Preplanned Technique: CSR#_____ (1–5)

Rescue Equipment Requirements: *(Indicate quantity needed)*

	Hauling systems		Carabiners		Pulleys
	Ascenders		Prusiks		Shock absorbers
	Anchor straps		Webbing		Rigging bags

Rescue Ropes Needed: *(Indicate quantity needed)*

	Main line(s)		Hauling systems		Lowering line(s)
	Safety line(s)		Line-transfer system(s)		

Medical and Packaging Equipment Needed: *(Indicate quantity needed)*

	Spinal immobilization device:		Stretcher device:
	C-collar:		Medical kit:

Additional PPE: *(See permit / MSDS)*

Designation of Rescue Personnel: *(Last name, first initial)*
- First responder(s): _____
- Team leader: _____
- Safety line(s): _____
- Back-up rescuer: _____
- Rigger: _____
- Attendant: _____
- Air watch: _____

Space Description:

Sketch or Diagram of Space: *(Use back of page if needed)*

Entry supervisor:	Phone:	Date:

Report completed by:

FIGURE I.1 An Example of Confined Space Rescue Plan.

Annex J Excavation Requirements and Soil Types

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

J.1

The following is excerpted from 29 CFR 1926.651, "Specific Excavation Requirements," and specifies soil types.

"Cemented soil" means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

"Cohesive soil" means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay, and organic clay.

"Dry soil" means soil that does not exhibit visible signs of moisture content.

"Fissured" means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

"Granular soil" means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

"Layered system" means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

"Moist soil" means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

"Plastic" means a property of a soil that allows the soil to be deformed or molded without cracking or appreciable volume change.

"Saturated soil" means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

"Soil classification system" means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of stable rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the characteristics of the deposits and the environmental conditions of exposure.

"Stable rock" means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

"Submerged soil" means soil that is underwater or is free-seeping.

"Type A" means cohesive soils with an unconfined, compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are clay, silty clay, sandy clay, clay loam, and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if one of the following conditions exists:

(1) The soil is fissured.
(2) The soil is subject to vibration from heavy traffic, pile driving, or similar effects.
(3) The soil has been previously disturbed.
(4) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater.
(5) The material is subject to other factors that would require it to be classified as a less stable material.

"Type B" means one or more of the following:

(1) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa)

(2) Granular cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam, and, in some cases, silty clay loam and sandy clay loam
(3) Previously disturbed soils except those that would otherwise be classed as Type C soil
(4) Soil that meets the unconfined compressive strength or cementation requirements for Type A but is fissured or subject to vibration
(5) Dry rock that is not stable
(6) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B

"Type C" means one or more of the following:
(1) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less
(2) Granular soils including gravel, sand, and loamy sand
(3) Submerged soil or soil from which water is freely seeping
(4) Submerged rock that is not stable
(5) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper

"Unconfined compressive strength" means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

"Wet soil" means soil that contains significantly more moisture than moist soil but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

The classification of soil should be made based on the results of at least one visual and at least one manual analysis. Such analyses should be conducted by a competent person using tests described in Appendix A (Soil Classification) of 29 CFR 1926, Subpart P, or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials or the U.S. Department of Agriculture textural classification system. The visual and manual analyses, such as those specified in Appendix A (Soil Classification) of 29 CFR 1926, Subpart P, should be designed and conducted to provide sufficient quantitative and qualitative information as might be necessary to identify properly the properties, factors, and conditions affecting the classification of the soil.

Annex K Informational References

K.1 Referenced Publications.

The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

K.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 220, *Standard on Types of Building Construction*, 1999 edition.

NFPA 471, *Recommended Practice for Responding to Hazardous Materials Incidents*, 2002 edition..

NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, 2002 edition.

NFPA 1006, *Standard for Rescue Technician Professional Qualifications*, 2003 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2002 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System*, 2002 edition.

NFPA 1581, *Standard on Fire Department Infection Control Program*, 2000 edition.

NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*, 1998 edition.

NFPA 1983, *Standard on Fire Service Life Safety Rope and System Components*, 2001 edition.

K.1.2 Other Publications.

K.1.2.1 BOCA Publication. Building Officials and Code Administrators International, 4051 W. Flossmoor Road, Country Club Hills, IL 60478.

National Building Code, 1999.

K.1.2.2 FEMA Publications. Federal Emergency Management Agency, 500 C Street, SW, Washington, DC 20472.

FEMA Earthquake Hazards Reduction Series 41, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook.*

FEMA *US&R Response System.*

K.1.2.3 ICBO Publication. International Conference of Building Officials, 5360 S. Workman Mill Road, Whittier, CA 90601.

Uniform Building Code, 1997.

K.1.2.4 SBCC Publication. Southern Building Code Congress International, 900 Montclair Road, Birmingham, AL 35213.

Standard Building Code, 1999.

K.1.2.5 U.S. Government Publications. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

National Search and Rescue Committee, *U.S. National Search and Rescue Supplement to the International Aeronautical and Maritime Search and Rescue Manual*, 2000.

National Search and Rescue Committee, *U.S. National Search and Rescue Plan*, 1999.

Title 29, Code of Federal Regulations, Part 1910.120, "U.S. Federal OSHA Standard on Hazardous Waste Operations and Emergency Response" (HAZWOPER).

Title 29, Code of Federal Regulations, Part 1910.146, "Permit-Required Confined Spaces," May 19, 1994.

Title 29, Code of Federal Regulations, Part 1910.1030 (OSHA), "Blood-Borne Pathogens," July 1, 1992.

Title 29, Code of Federal Regulations, Part 1926, Subpart P, Appendix A, "Soil Classification," July 1, 1995.

Title 29, Code of Federal Regulations, Part 1926, Subpart P, Appendix C, July 1, 1995.

Title 29, Code of Federal Regulations, Part 1926, Subpart P, Appendix B, "Excavations, Sloping and Benching," August 9, 1994.

Title 29, Code of Federal Regulations, Part 1926.651, "Specific Excavation Requirements," August 9, 1994.

Title 29, Code of Federal Regulations, Part 1926.652.

K.1.2.6 Other Publications.

IMO/ICAO, *International Aeronautical and Maritime Search and Rescue Manual: Vol. I – III*, International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO), London/Montreal, 1999.

K.2 Informational References.

The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

The following list provides additional sources for information on the operations and training of technical rescue incidents.

ADC, *Consensus Standards for Commercial Diving Operations,* Third Edition, American National Standards Institute, 1991.

Auerbach, Paul S., Editor, *Wilderness Medicine: Management of Wilderness and Environmental Emergencies,* Fourth Edition, Mosby-Year Book, Inc., 2000.

Barsky, Steven M., *Diving in High Risk Environments,* Third Edition, Dive Rescue International, Inc., 1999.

Bechel, Les and Ray, Slim, *River Rescue,* Second Edition, Appalachian Mountain Books, Boston, 1989.

Benkoski, M., Monticino, M., and Weisinger, J., "A Survey of the Search Theory Literature," *Naval Research Logistics*, 1991.

Bownds, J.M., Ebersole, M., Lovelock, D., and O'Connor, D., *Searchbusters: Reexamining the Search Management Function*, Private publication, Phoenix, AZ, 1990.

Brown, Michael G., *Engineering Practical Rope Rescue Systems*, Delmar-Thompson Learning Publishers, 2000.

Charnes, A., & Cooper, W.W. (1958). The theory of search: optimal distribution of search effort. *Management Science, 5*, pp. 44-50.

CMC Rescue, Inc., *Confined Space Entry and Rescue: A Training Manual,* 1996.

Colwell, M., *Search Priority: an integrated approach to search planning*, Private publication, British Columbia, Canada, 1994.

Cooper, D., LaValla, P., & Stoffel, R. (1996). *Search and rescue fundamentals: Basic skills and knowledge to perform wilderness, inland, search and rescue*. Third edition, revised. Olympia, Washington: ERI, Inc., and D.C. Cooper.

Cooper, D.C. (2000). *The application of search theory to land search: The adjustment of probability of area*. Private Publication, 20 March 2000, Cuyahoga Falls, Ohio, U.S.A.

Cooper, D.C., and Frost, J.R., *Selected Inland Search Definitions*, published by the author, Cuyahoga Falls, OH, 2000.

Cooper, D.C., "An Outline of Selected Concepts of Land Search Theory," *NASAR Conference Proceedings*, Response '98, 27th Annual Conference and Exhibition of the National Association for Search and Rescue, 1998.

Downey, Ray, *The Rescue Company,* Fire Engineering, Saddle Brook, NJ, 1992.

Drabek, Thomas E., *The Professional Emergency Manager,* University of Colorado, Institute of Behavioral Science, 1987.

Drabek, Thomas E., et al, *Managing Multiorganizational Emergency Responses: Emergency Search and Rescue Networks in Natural Disaster and Remote Area Settings,* University of Colorado, Institute of Behavioral Science, 1981.

Dunn, Vincent, *Collapse of Burning Buildings, A Guide to Fireground Safety,* Fire Engineering, New York, 1988.

Dunn, Vincent, *Safety and Survival on the Fireground,* Fire Engineering, Saddle Brook, NJ, 1992.

Fasulo, David J., *Self Rescue,* Chockstone Press, Evergreen, CO, 1996.

FEMA, *New Techniques in Vehicle Extrication,* Federal Emergency Management Agency, Emmitsburg, MD, September, 1994.

FEMA, *Urban Search and Rescue Response System—Operational System Description and Mission Operational Procedures,* Federal Emergency Management Agency, Emmitsburg, MD.

Field, Ernest, K., Editor, *Mountain Search and Rescue Operations,* Grand Teton Natural History Association, Moose, WY, 1969.

Frost, J.R. (1999a). Principles of search theory, part I: detection. *Response*, 17(2), pp. 1-7.

Frost, J.R. (1999b). Principles of search theory, part II: effort, coverage, and POD. *Response*, 17(2), pp. 8-15.

Frost, J.R. (1999c). Principles of search theory, part III: probability density distributions. *Response*, 17(3), pp. 1-10.

Frost, J.R. (1999d). Principles of search theory, part IV: optimal effort allocation. *Response*, 17(3), pp. 11-23.

Frost, J.R. (1998a). *What's missing from ground search theory*. Fairfax, Virginia: Soza and Company, Ltd.

Frank, James A., *Rope Rescue Manual,* CMC Rescue, Inc., Third Edition, 1998.
Frank, James A., and Patterson, Donald E., *Rappel Manual,* Second Edition, CMC Rescue, Inc., Santa Barbara, CA, 1997.
Gargan, James B., *Trench Rescue,* Mosby Lifeline, Second Edition, 1996.
Goodson, Carl, Editor, *Fire Service Rescue,* Sixth Edition, International Fire Service Training Association (IFSTA), Fire Protection Publications, Stillwater, OK, 1996.
Goodson, Carl, *Principles of Vehicle Extrication,* Second Edition, International Fire Service Training Association (IFSTA), Fire Protection Publications, Stillwater, OK, 2000.
Hendricks, Walt "Butch," and Zaferes, Andrea, *Surface Ice Rescue*, Fire Engineering Books & Videos, Tulsa, OK, 1999.
Hill, Kenneth, Editor, *Managing the Lost Person Incident,* National Association for Search and Rescue, Chantilly, VA, 1997.
Hudson, Steve, Editor, *Manual of U.S. Cave Rescue Techniques,* Second Edition, National Speleological Society, Huntsville, AL, 1988.
Jackson, F. and Bielmaier, M., Standard Operating Procedures and Guidelines Manual, Dive Rescue Intl., Inc., 2002.
Jackson, F., Carney, J. and White, L., Public Safety Diver Survival, International Association of Dive Rescue Specialist, 2002.
Koopman, B.O., *Search and Screening: General Principles with Historical Applications*, Pergamon, New York, NY, 1980.
LaValla, P., Stoffel, R., and Jones, A.S.G., *Search is an Emergency: A Text for Managing Search Operations,* Fourth Edition Revised, Emergency Response Institute, Olympia, WA, 1996.
Linton, S. J., Rust, D. A., and Gilliam, T. D., *Diver Rescue Specialist Training Manual,* Dive Rescue Inc./International, Fort Collins, CO, 1986.
Lipke, Rick, *Technical Rescue Riggers Guide,* Conterra Technical Systems Inc., Bellingham, WA, 1997.
Long, John, *Climbing Anchors,* Chockstone Press, Evergreen, CO, 1993.
Long, John and Gaines, Bob, *More Climbing Anchors,* Chockstone Press, Evergreen, CO, 1996.
Lonsdale, Mark V., *SRT Diver,* Los Angeles, 1999 .
Maryland Fire and Rescue Institute, *Rescue Technician – Student Manual*, University of Maryland, College Park, MD, 1998.
Mattson, R.J., *Establishing Search Priorities*, Private publication, 1975.
Mickle, J.L., "The Mechanics of a Trench Cave-In," *Agri-book Magazine/Drainage Contractor*, 1991.
NFPA, *Comprehensive Glossary of Terms,* Version 2.0, National Fire Protection Association, Quincy, MA, 1997.
NOAA Manual, National Oceanic and Atmospheric Administration, Fourth Edition, 2001.
Norman, John, *Fire Officer's Handbook of Tactics,* Fire Engineering, Saddle Brook, NJ, 1991.
Nudell, Mayer and Antokol, Norman, *The Handbook for Effective Emergency and Crisis Management,* Lexington Books, Lexington, MA, 1988.
NYS Office of Fire Prevention & Control, *Confined Space Awareness and Safety* (Lesson Plan and Student Manual), Albany, NY, 1994.
NYS Office of Fire Prevention & Control, *Confined Space Rescue* (Lesson Plan and Student Manual), Albany, NY, 2001.
Ohio Department of Natural Resources, Division of Watercraft, *River Rescue,* Instructional Materials Laboratory, Ohio State University, 1980.
Oklahoma State University Environmental Health and Safety, *Trenching and Shoring Procedures*, Stillwater, OK, 1996.
Padgett, Allen and Smith, Bruce, *On Rope,* Second Edition, National Speleological Society, Huntsville, AL, 1998.
Ray, Slim, *Swiftwater Rescue,* CFS Press, Asheville, NC, 1997.
Rekus, John F., *Complete Confined Spaces Handbook,* Lewis Publishers, 1994.
Revised Instructional Standards Minimum Course Content for Entry Level SCUBA Certification, September 1986.

Roco Corporation, *Compliance Guidelines for Confined Space Rescue.*
Roop, M., Wright, R., and Vines, T., *Confined Space and Structural Rescue,* Mosby, 1998.
Sargent, Chase N., *Confined Space Rescue*, Fire Engineering, Saddle Brook, NJ, 2000.
Soza and Company, Ltd., and U.S. Coast Guard, *The Theory of Search: a Simplified Explanation*, (Revised Edition), published by the authors, Fairfax, VA, 1998.
Stanevich, R.L., and Middleton, D.C., "An Exploratory Analysis of Excavation Cave-in Fatalities," *Professional Safety*, 1988.
Stone, L.D. (1989). *Theory of Optimal Search* (Second ed.). Military Applications Section, Operations Research Society of America. Arlington, Virginia: ORSA Books.
Syrotuck, W.G., *Some grid search techniques for location lost individuals in wilderness areas*, Arner Publications, Westmoreland, NY, 1974.
Syrotuck, W.G., Analysis of lost person behavior: an aid to search planning, Syrotuck, J.A., (Ed.), Arner Publications, Westmoreland, NY, 1976.
Taylor, A. and Cooper, D.C. (1990). *Fundamentals of mantracking: The step-by-step method*. Second Edition. Olympia, Washington: ERI, International.
Thrun, Robert, *Prusiking,* National Speleological Society, Huntsville, AL, 1973.
United States Fire Administration, *Protective Clothing and Equipment Needs of Emergency Responders for Urban Search and Rescue,* Federal Emergency Management Agency, Emmitsburg, MD, 1994.
United States Fire Administration, *Technical Rescue Program Development Manual,* Federal Emergency Management Agency, Emmitsburg, MD, August, 1995.
United States Fire Administration, *Technical Rescue Technology Assessment,* Federal Emergency Management Agency, Emmitsburg, MD, January 1995.
United States Lifesaving Association, *Guidelines for Training & Standards of Aquatic Rescue Response Teams,* 1996.
U.S. Department of Commerce, *NOAA Diving Manual,* October 1991.
U.S. Department of Labor (OSHA Technical Manual), *Excavations: Hazard Recognition in Trenching and Shoring*, 1999.
U.S. Department of Labor (OSHA Construction Resource Manual) CFR 1926, Subpart P, *Excavations*, 1996.
U.S. Navy, *U.S. Navy Diving Manual,* Commander, Naval Sea Systems Command and Best Publishing Co., Version 4.
Viking, Diving in Contaminated Water Database Manual, Trelleborg-Viking, Copyright 2001.
Vines, Tom and Hudson, Steve*, High Angle Rescue Techniques: A Student Guide for Rope Rescue Classes,* National Association for Search and Rescue, Fairfax, VA, 1989.
Wheelock, Walt, *Ropes, Knots and Slings for Climbers,* La Siesta Press, Glendale, CA, 1967.
Worsing, Robert A., Jr., MD, *Basic Rescue and Emergency Care,* American Academy of Orthopaedic Surgeons, Park Ridge, IL, 1990.

K.3 References for Extracts.

The following documents are listed here to provide reference information, including title and edition, for extracts given throughout this standard as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, 2002 edition.
NFPA 1006, *Standard for Rescue Technician Professional Qualifications*, 2003 edition.
NFPA 1021, *Standard for Fire Officer Professional Qualifications*, 2003 edition.
NFPA 1521, *Standard for Fire Department Safety Officer*, 2002 edition.
NFPA 1561, *Standard on Emergency Services Incident Management System*, 2002 edition.
NFPA 1983, *Standard on Fire Service Life Safety Rope and System Components*, 2001 edition.

Index