NFPA® 1402

Guide to Building Fire Service Training Centers

2012 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA® 1402

Guide to

Building Fire Service Training Centers

2012 Edition

This edition of NFPA 1402, *Guide to Building Fire Service Training Centers,* was prepared by the Technical Committee on Fire Service Training. It was issued by the Standards Council on December 13, 2011, with an effective date of January 2, 2012, and supersedes all previous editions.

This edition of NFPA 1402 was approved as an American National Standard on January 2, 2012.

Origin and Development of NFPA 1402

In 1963, a subcommittee of the Fire Service Training Committee developed a document titled *How to Build Firemen's Training Centers*. That informative report was published and circulated as a guide and served to improve the scope and efficiency of fire fighter training. By 1985, the report had evolved into the first edition of NFPA 1402, *Guide to Building Fire Service Training Centers*. Revisions to NFPA 1402 were published in 1992 and 1997.

The Fire Service Training Committee appointed a Task Group to review the 1997 edition and make recommendations concerning the functionality of the document. After that review, the Task Group recommended a general updating of NFPA 1402, which was undertaken for the 2002 edition.

In addition to minor edits to address the general evolution of the subject, the Committee placed more emphasis in the 2002 edition on needs analysis before design and construction, establishing policies and procedures for effective use of the structure, and the environmental impact of training and training props.

New material was added to the chapter on gas-fired burn props. The chapter on design and construction was renamed "Selecting an Architect/Engineer (A/E)" and placed more emphasis on the important roles played by these professionals and on the contract documents that form the foundation of projects for building fire service training centers. The chapter on burn buildings was renamed "Live Fire Training Structure" and placed more attention on these structures, especially regarding the impact of repeated high temperatures.

The 2007 edition of the guide included updated material on needs and cost analysis, training center components and considerations, and infrastructure considerations and exposures. The guide also included many new and updated illustrations.

The 2012 edition includes a rewritten Chapter 7, Design and Construction Process, to aid the user in the workflow. Chapter 10, Live Fire Training Structure, has also been rewritten to clarify some issues and make the document more user friendly, with Section 10.7 including suggested gas-fired live fire training safeguards.

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Committee Scope: This Committee shall have primary responsibility for all fire service training techniques, operations, and procedures to develop maximum efficiency and proper utilization of available personnel. Such activities can include training guides for fire prevention, fire suppression, and other missions for which the fire service has responsibility.

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Guide to

Building Fire Service Training Centers

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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, the complete title and edition of the source documents for extracts in advisory sections of this document are given in Chapter 2 and those for extracts in the informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope. This guide addresses the design and construction of facilities for fire service training. It covers the aspects that should be considered when planning a fire service training center. It should be understood that it is impractical to list every item that might be included in a training center or every type of specialty training facility that might be constructed. Therefore, the main components of a training center necessary to accomplish general fire fighter training effectively, efficiently, and safely are presented here.

1.2 Purpose. This document provides guidance for the planning of fire service training centers. Regardless of whether a particular situation requires inclusion of all the items specified, they are provided to provoke thought. This guide is intended to assist in the identification of those elements that are of the greatest benefit to those involved in planning and constructing training centers.

1.3 Application. Some of the structures in a fire service training center are designed to be training props and are not required to meet all of the requirements of the jurisdiction's building codes. However, the structural integrity of all training structures and props must be ensured.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this guide and should be considered part of the recommendations of this document.

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

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2010 edition.
NFPA 54, *National Fuel Gas Code,* 2012 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2011 edition.
NFPA 70®, *National Electrical Code*®, 2011 edition.
NFPA 72®, *National Fire Alarm and Signaling Code,* 2010 edition.
NFPA 79, *Electrical Standard for Industrial Machinery,* 2012 edition.
NFPA 86, *Standard for Ovens and Furnaces,* 2011 edition.

2.3 Other Publications.

2.3.1 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 508A, *Standard for Industrial Control Panels,* 2001. Revised 2010.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Advisory Sections.

NFPA *101*®, *Life Safety Code*®, 2012 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter apply to the terms used in this guide. Where terms are not defined in this chapter or within another chapter, they should be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, is the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1 Guide. A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

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

3.3 General Definitions.

3.3.1* Live Fire Training Structure. A structure specifically designed for conducting live fire training evolutions on a repetitive basis.

3.3.2 Means of Escape. A way out of a building or structure that does not conform to the strict definition of means of egress but does provide an alternate way out. [***101*,** 2012]

Chapter 4 Needs Analysis

4.1 General. Fire service training programs should be analyzed to determine the type of training that is required. Is a fire service training center necessary? If the answer is yes, then the initial step is to develop a statement on the broad purpose of the center. An example of such a statement follows: "Ever-changing technologies in fire suppression and fire prevention require that today's fire fighter be knowledgeable and well trained. A proper environment for obtaining this knowledge and training is equally important. This fire service training center provides the facilities required for fire training and enhances the community's well-being through better fire protection and fire prevention."

4.1.1 The construction of a fire service training center, regardless of its size, involves planning, design, and the expenditure of funds. In order to maximize benefits from the resources available, an assessment of current and future needs should be made. This assessment should consider the following:

(1) Current and future training needs
(2) Facilities currently available
(3) Organizations or departments using the training center, including potential teaming partners from around the region
(4) Viable alternatives to new construction
(5) Fuel sources
(6) Land availability
(7) Suitability of land for purpose
(8) Future plans for land adjoining the facility

4.1.2 The resources available will define the limitations of facility development and construction. Resources include money, land, and support from the government, private enterprise, and the community. Questions concerning the availability of resources should be answered during the planning of a training center.

4.2 Alternative Facilities. If a fire department requests a new training center, its existence needs to be justified. The use of existing facilities at the state or regional level should be explored. If the department is located in an industrial area, the possibility of using the fire training facilities of the local plants should be considered.

4.3 New Fire Service Training Center. If it is decided that a new fire service training center is to be built, certain factors need to be considered.

4.3.1 Cost Considerations. The question of who is to assume the cost must be asked. Both initial and ongoing costs need to be identified, including the following:

(1) Site acquisition
(2) Fees (legal, permitting, and architectural)
(3) Construction
(4) Furnishings
(5) Staffing
(6) Apparatus and equipment
(7) Maintenance (buildings, grounds, training props, and equipment)
(8) Utilities (water, electricity, gas)
(9) Fuel
(10) Noise, smoke, and water abatement
(11) Roadway systems

4.3.2 Cost-Benefit Analysis.

4.3.2.1 A cost-benefit effectiveness analysis should be conducted to enable a community to determine whether the investment is cost-effective and if it is feasible to contribute to long-range financial support. This analysis should include consideration of cost-saving opportunities, such as determining which departments and agencies will use the training center, so that costs can be shared by multiple budgets; identifying state, county, and regional training agencies that might wish to sponsor their programs at the training center; and finding local industrial plants that might be willing to contribute to the costs of the training center. An example of one of these options is that local police might share a need for driver training, physical fitness, tower training, and use of various spaces, such as auditoriums, classrooms, offices, and conference rooms. Another example is combining the training center with an in-service fire station, which could satisfy two needs and reduce the total financial impact of separate facilities.

4.3.2.2 Finding ways to reduce construction, operations, and maintenance costs should be part of the cost-benefit analysis. Modular construction, including pre-engineered structures, could be cost-effective for training structures and for administration, classroom, storage, and other facilities. Exploring various site layouts, construction phasing, grant opportunities, and alternatives for training props should be part of the analysis.

4.3.2.3 The cost-benefit analysis should include an evaluation of potential cost savings for current training expenditures that might not be necessary if a training center is built. Examples include the following:

(1) Fees paid to use facilities at other training centers
(2) Travel costs, such as fuel, overtime pay, lodging, and per diem, associated with training at other training centers
(3) Costs associated with preparing acquired structures for training evolutions

4.3.3 Intangible Benefits. Potential intangible benefits could help a community accept the need for building a new training center. It might be beneficial to organize a commission or advisory group to interface between governing bodies and the fire training agency. The group should include representatives of the agencies, organizations, and departments that will use the training center. Such a group could weigh the importance of the following potential benefits:

(1) Reduced injuries and deaths of civilians and fire fighters
(2) Reduced number of fires and property damage
(3) Increased efficiency and morale of the fire-fighting force
(4) Improved training capability and public image of the fire department

Chapter 5 Components and Considerations

5.1 General. This chapter lists general components that could be part of a training center. Other components that might be unique to a particular area of industry are not included. For the purpose of this guide, the buildings, training structures, and training props are discussed separately; however, combinations of these components might be necessary or advantageous. As long as the function of an individual component is not compromised, each component can be located wherever it is conducive to effective training and safety. The installation of all components is not necessary for an efficient training center. The following list of components should be considered:

(1) Administration and support facilities components, as follows:
  (a) Offices
  (b) Conference areas
  (c) Library
  (d) Photo laboratory and darkroom
  (e) Printing and copying area
  (f) Graphics and audiovisual aid preparation area
  (g) Student housing, dorms, and recreation facilities

(h) Food service facilities, cafeteria, kitchenette, or break room
(i) Restroom and locker facilities
(j) Apparatus maintenance and repair center
(k) Equipment and supply facility
(l) Storage space for various materials
(m) Communications center
(n) Data processing area
(o) Medical area, infirmary, or first aid
(p) Records storage
(q) Computer facilities
(r) Video production area
(s) Multimedia facilities
(t) Internet connections
(u) Broadcasting capabilities
(v) Self-contained breathing apparatus (SCBA) maintenance, repair, and refilling area

(2) Indoor instructional facilities components, as follows:
(a) Classrooms ("clean" and "dirty")
(b) Breakout areas for classes
(c) Auditorium
(d) Physical fitness area
(e) Pool for water rescue training
(f) Technical rescue training areas
(g) Special training laboratories components, as follows:
i. Simulators
ii. Automatic sprinklers
iii. Pumps
iv. Emergency medical services (EMS) and rescue
v. Fire alarm systems
vi. Arson laboratory
(h) Infrastructure for recording classroom sessions and for distance learning equipment
(i) Storage space for equipment and props

(3) Outside facilities components, as follows:
(a) Drill tower
(b) Drafting pit
(c) Live fire training structure
(d) Emergency vehicle operations course (EVOC) — driver training area
(e) Flammable liquids and gases and fuel distribution area for outdoor gas-fired props, such as the following:
i. Fuel spill fire
ii. Vehicle fire (car, bobtail truck, other)
iii. Dumpster fire
iv. LP tank fire
v. Gas main break fire
vi. Christmas tree fire
vii. Industrial fire
(f) Hazardous materials containment and decontamination areas
(g) Outside classroom areas (could combine with rehabilitation areas, storage space, and/or restrooms)
(h) Helicopter landing site
(i) Respiratory protection training laboratory
(j) Storage space for portable equipment, vehicles, and props
(k) Bleachers for outdoor classes or observation of drill tower activities
(l) Fire station
(m) Outside rehabilitation areas (could combine with outside classroom, storage space, and/or restrooms)
(n) Technical rescue area (e.g., high angle, collapse, trench, confined space, vehicle extrication)
(o) Safety monitoring and control areas
(p) Rail incident training (with or without fire)
(q) Aircraft incident training (with or without fire)
(r) Shipboard incident training (with or without fire)
(s) Fire behavior laboratory ("flashover container")
(t) Extinguisher training
(u) Swift water rescue training
(v) Rapid intervention crew (RIC) ("Saving Your Own") training prop
(w) Mock city (with or without fire) — could also be used for multiagency training

(4) Infrastructure components, as follows:
(a) Water distribution, sewer, and other utilities
(b) Parking facilities (open and covered)
(c) Site maintenance equipment and facilities
(d) Environmental cleanup activities
(e) Communications
(f) Water filtration and reclamation
(g) Security infrastructure for site, buildings, storage areas, and training grounds

5.2 Donated Land, Buildings, Training Structures, and Training Props. Fire departments are sometimes offered donations of land, buildings, or existing facilities that could be converted into training structures or training props. Such donations should be evaluated before being accepted to ensure that the training, operational, and budgeting needs can be fulfilled safely and in a practical manner. In some cases, the department might not be able to afford the donation, or the donation might not be suitable. The following questions should be considered before accepting donations:

(1) Is the donated land going to be difficult and/or expensive to develop due to any of the following:
(a) It is an old landfill.
(b) It contains hazardous materials.
(c) It includes wetlands.
(d) It has poor soils that cannot support buildings.
(e) It includes rock that will be expensive to excavate.
(f) It is an endangered species habitat or a wildlife preserve.
(g) It is located in a flood plain.
(h) It is historic property with developmental restrictions.
(i) It is located adjacent to neighbors who cannot tolerate noise, smoke, lights at night, or other disruptions inherent in fire training.
(j) It is not located near sources of water, power, sewer, or other utilities.
(k) It poses other problems that would make it difficult or expensive to develop.
(2) Is the donated structure in good structural condition and suitable for conversion into a fire training structure or prop?
(3) Is the structure suitable for live fire training, rappelling, and other types of training?
(4) Is the donated building in good condition and free of asbestos, lead, or other hazardous materials?
(5) Is the building free of structural deficiencies, termites, mold, roof leaks, or other problems that could be expensive to repair?
(6) Will the building code allow the building to be converted into a classroom or administration building?

5.3 Planning Considerations. Because a training center is a specialized facility, there are a number of specific features that should be considered. Since a training center will probably be expected to be used for 40 or 50 years, it is desirable to rely on the experience gained by others. The remaining chapters of this document provide some specific areas of guidance, and the following general guidelines also should be considered:

(1) Conflicts with the local area master plan and zoning criteria should be avoided.
(2) Possible joint use with other agencies should be investigated.
(3) Available grant funds should be explored.
(4) An environmental impact statement could be required, depending on the requirements of the AHJ.
(5) Existing training centers should be visited for ideas and experience; new training centers might exhibit state-of-the-art features, while older training centers might identify operational and/or maintenance problems to be avoided.
(6) Weather-related problems and the effects of seasonal use should be considered.
(7) It should be determined if any part of the training center will be used at night.
(8) Ample space should be provided between buildings/outdoor facilities to enable simultaneous use.
(9) Ample, secured storage space should be provided for each segment of the training center.
(10) Site landscaping with minimum upkeep that complements the training activities and that buffers the site from neighbors should be selected.
(11) Interior/exterior finishes that require a minimum of maintenance should be chosen.
(12) Heating and air-conditioning equipment should be located where regular maintenance can be performed easily, but the installation of individual units in classroom areas should be avoided.
(13) Separate locker and restroom facilities should be provided for male and female occupants, and separate facilities should be provided for staff and students.
(14) The space needed for guests and visitors, staff, and future users should be identified.
(15) Slip-resistant surfaces should be specified for all stairs and well-traveled paths.
(16) Automatic sprinklers and smoke detectors should be specified for appropriate areas.
(17) Facilities for the storage of fuel used in training should be considered.
(18) Facilities for the refueling of apparatus could be considered.
(19) Communications should be provided between structures and training areas.
(20) Storage for apparatus, especially during cold weather, should be considered.
(21) Drinking water facilities should be provided at all drill sites, including those outdoors.
(22) Emergency shower and eye wash stations should be provided.
(23) Lighting should be provided in as many areas of the buildings, props, and training grounds as practical to assist in locating personnel.
(24) An intercom system that could be used throughout the training center should be installed.
(25) Budgets should be established for construction, operations, and maintenance.

5.4 Usage Guidelines. Policies and procedures should be developed regarding the use of the training center. The needs of the prospective users should be fulfilled by proper scheduling. User insurance coverage should be verified before any use is authorized. Careful explanation of the usage guidelines should be given to all instructors, guest instructors, and other users. Formal training should be provided to all instructors and safety officers who use the training center, especially with respect to live fire training structures and props, and the following actions should also be taken:

(1) Be certain to provide a tour and specify where fires are to be lighted and the maximum amount of combustibles to be burned.
(2) Make sure participants know how to report damage to the training structures and props, as well as any injuries that occur during the training activities.
(3) Ensure that facilities with computer-controlled gas-fired burn props have qualified operator and maintenance personnel available.
(4) Include a package of material that contains all important phone numbers, contact personnel, and required forms.

Chapter 6 Infrastructure Considerations and Exposures

6.1 General. Certain factors that should be considered in determining the location of the training center in the community include the site, water supply, environment, security, support services, and access to utilities.

6.2 Site Considerations.

6.2.1 Some questions that should be asked when considering site locations include the following:

(1) What land is available?
(2) Does the agency own land that could be considered as a site?
(3) Are there abandoned properties available?

6.2.2 The cost of the land should be included in the agency's budget. A sequential spending plan might allow for the purchase of the necessary land one year and the construction of certain buildings thereafter. A sequential plan could enable the community to realize its objective over an extended period of time rather than placing pressure on current resources for immediate large expenditures. On the other hand, using a bond issue to build at the current year's rate and paying off with future dollars could be more cost-effective. Financial consultation is recommended.

6.2.3 An architect/engineer (A/E), a civil engineer, or the municipality's staff engineer should be consulted during planning stages, before land is acquired, to determine if there are potential issues that could make the land difficult and/or expensive to develop, such as wetlands, environmental issues, endangered species habitats, wildlife preserves, flood plains, and the presence of hazardous materials.

6.2.4 Hidden subsurface conditions could pose logistical and budget problems. A geotechnical engineer should be consulted during planning stages to determine if the soils are suitable for supporting buildings and paving and to identify potential hidden problems, such as rock, loose fill, ledge formations, or a high water table.

6.2.5 The area master plan, if one exists, should be taken into consideration. The site of the training center should be located as follows:

(1) Away from the center of community life to minimize negative impact on adjacent land use
(2) As centrally located as possible for the departments and personnel that will be using it, to minimize travel time and remoteness from protection districts

6.2.6 If a favorable site requires a plan variance, all pertinent facts should be gathered, and a presentation should be made to the planning board. If possible, the area master plan should be used to support the agency's advantageous position. The voting public should be informed of the advantages of the training center, and every effort should be made to develop public support.

6.2.7 The title to the property should be clear. The potential for future expansion is often desirable, so the surrounding land should be surveyed. A land use determination from the planning board for fire training is beneficial. This requires the municipality to check with the agency before allowing other types of usage. If possible, the site should be marked prominently on land maps and should be surrounded by a nonresidential area. A lawyer's guidance could be advantageous in such cases.

6.2.8 Vehicle traffic patterns should be studied, and the most convenient route to the training center should be identified. Heavy, noise-producing apparatus should be routed to avoid residential areas. Travel time to the training center for users should be taken into consideration. On-duty personnel who are receiving in-service training at the training center could be required to respond to emergency incidents; therefore, the training center should be located so that it is accessible to appropriate emergency response routes.

6.2.9 The size of the site should be ample for planned buildings, training structures and props, parking, and future expansion. Adequate separation should be planned between buildings, training structures, and props for safety, vehicular movement, and instructional purposes. In some cases, it might be better to conserve on the size of structures than to overcrowd limited land.

6.2.10 Site pavement should be such that the training center can be used in all kinds of weather. Any pavement will deteriorate, especially when subjected to hydrocarbons or hot exhausts. Concrete pavement withstands training center usage with minimum maintenance.

6.2.11 Landscaping and site layout should take into consideration local climatic conditions. Consideration should be given to rain, snow, wind, heat, and other adverse elements that could affect facility operations. Site layout could incorporate a roadway system that is typical of the community. This could be helpful in the training of apparatus operators.

6.3 Water Supply.

6.3.1 The maximum water supply required should be estimated so that an adequate system is installed to deliver the necessary water volume and pressure for training activities, facility fire protection systems, and domestic water needs. Water supply estimates should include the amount of water used in attack lines, backup lines, and drafting and pumping exercises, with an additional 100 percent included as a safety factor. A loop or grid system with properly placed valves could help to ensure adequate water delivery. Dead-end mains should be avoided. Valves should be placed to segregate sections of the water system to allow for repairs without complete shutdown.

6.3.2 The type of hydrant(s) installed at the training center should be representative of types found in the community. Where more than one community uses the training center and the hose threads are not uniform, a variety of fittings with appropriate threads should be provided.

6.3.3 Even where there is a hydrant system, drafting could provide an additional source of water. During times of water emergency, drafting might be necessary. Lakes or ponds, streams, man-made containers, and dry hydrants are potential drafting sources. Consideration should be given to supplying water from the water distribution system to maintain the water level in the drafting pit.

6.3.4 The on-site water supply needs should be determined and storage containers constructed, if necessary. Elevated, surface, or underground storage could be used. Pumps also could be used to move water at the desired pressure.

6.3.5* For durability, the water main should meet the requirements of NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, and be constructed with bolted flanges or steel-rodded joints. If severe turns have to be engineered into the piping, consideration should be given to thrust blocks. Flanges and joints both help overcome the effect of water hammer.

6.3.6 Tank trucks or long relays could be used to provide water for training. However, this practice increases the number of vehicles and personnel needed to accomplish basic evolutions, and it further increases the vehicular accident potential and maintenance cost.

6.3.7 A pumper test pit could be used as a cistern if water mains are not available.

6.3.8 A runoff settling pond equipped with a dry hydrant could be used as a water source.

6.4 Security.

6.4.1 The training center should be secure. The site should be fenced and well lighted, and, if necessary, a guard should be provided. Local police could make the training center a part of their rounds. Security could be augmented by alarm systems with connections to appropriate monitoring stations. Buildings, training structures, elevator shafts, drafting pits, underground utility covers, and all exterior valves and cabinets should be locked.

6.4.2 An evacuation signaling system and an automatic fire detection and alarm system should be installed throughout the training center in accordance with *NFPA 72, National Fire Alarm and Signaling Code*. A central station connection should be provided where a 24-hour guard is not posted at the control/monitor center.

6.5 Environment.

6.5.1 Federal, state, and local environmental protection agencies should be consulted. The results of these consultations could facilitate procurement of the necessary permits and licenses. These consultations should address the problem of waste water (treatment and disposal) and pollution (air, water, and noise). The facts gleaned from these agency contacts could be of use when the A/E is consulted.

6.5.2 When selecting a site for a training center, there are environmental factors to consider. It is important to ensure that the training center is environmentally safe. Factors that should be considered from an environmental aspect are water, air, and the ground (soil).

6.5.2.1 There are governmental agencies that have a jurisdictional interest in the location, design, and construction of a training center. These include agencies at the federal level, such as the Army Corps of Engineers and the Environmental Protection Agency. Each state or municipality, or both, also has regulatory agencies from which approval might be necessary prior to the construction of a training center. Most of the regulatory agencies do not have the resources or the staff to assist in planning a training center but will, in most cases, review designs.

6.5.2.2 There should be an environmental review by professional engineers, geologists, hydrologists, and environmental scientists. These professionals should develop an environmental impact study to determine what effect, if any, the training center will have on the environment.

6.5.2.3 There are three water-related issues that should be considered when planning a training center, as specified in 6.5.2.3.1 through 6.5.2.3.3.

6.5.2.3.1 The first consideration should be the disposal of waste water from fire-fighting operations. Waste water varies in its degree of contamination, depending on the evolutions that are performed. If evolutions involve flammable or combustible hydrocarbons or other potentially environmentally detrimental chemicals or compounds, provisions should be made for separating the contaminants from the runoff. (Waste water treatment could be reduced by using propane or natural gas in lieu of flammable liquid.) Separation of contaminants could be accomplished by oil separators, ponding, and bacteriological breakdowns. Care should be taken to prevent contaminating groundwater. The training center should be designed to take advantage of runoff to replenish supplies for training. Consideration should be given to storm water management, including limiting the amount of new impervious surface (buildings and pavement) created, so that runoff does not affect surrounding properties. Care should be taken to prevent damage to any wetlands in the area.

6.5.2.3.2 The second water-related issue that should be considered is the need for potable water for use by the trainees, visitors, and staff. This water could come from wells or a municipal source.

6.5.2.3.3 The third water-related issue that should be considered is fire-fighting water, including water for automatic sprinklers for the buildings. The use of fresh potable water for training purposes should be discouraged because of the large volumes involved and the waste of a shrinking resource.

6.5.2.4 The prevalent wind direction and force should be considered when selecting the location of a training center and when selecting the location of buildings at the training center. Smoke generated by the training center should not interfere with the surrounding area or buildings. The residue from extinguishing agents and the products of combustion have been found at considerable distances from training sites. The use of a wind sock on the training ground could assist instructors in evaluating the effect of wind on the areas surrounding the training center. Light generated by fires, particularly at night, should be considered if the training center is to be located near an airport, residential communities, or other facilities that might be adversely affected by nighttime lighting. Noise is also a factor that should be considered. The existing terrain should be used to direct noise away from populated areas.

6.5.2.5 Taking advantage of the shape and contour of the land to develop runoff patterns and establish locations for various buildings and props, so that they do not interfere with the drainage of the water during all seasons and weather conditions, should be a goal of the training center designer. The type of soil at the training center location is important. The type of soil and geology affects such factors as foundation type, bearing capacity, pavement life, and runoff, both above and below the surface, and it could indicate the presence of rock, which could be expensive to remove.

6.6 Utilities.

6.6.1 The use of pumps, air compressors, and simulators, and heat, ventilation, and air-conditioning (HVAC) units, could greatly increase power requirements. An on-site total energy system might be a practical alternative. Such systems consist of a mechanical package on site that provides utility services (e.g., electrical, heating, air-conditioning) for use in buildings. The largest portion of the electrical needs is usually dictated by the number of buildings and their purposes.

6.6.2 The need for power, natural gas feed, computer and Internet connections, telephone connections, and other communications should be considered. The distance of the training center from these services could be a factor in determining its location.

6.6.3 Electrical outlets should be installed in sufficient numbers to prevent the use of extension cords. The electrical outlets should be installed in accordance with *NFPA 70, National Electrical Code.*

6.7 Support Services. Where housing and food services are to be provided, space should be planned for such purposes. Food service could be provided by a private vendor. The transportation of staff and trainees, housekeeping and laundry services, vending machine location, janitorial service, and ground and facility maintenance should be considered. Provisions should be made to address the recycling requirements of the jurisdiction.

Chapter 7 Design and Construction Process

7.1 Working with an Architect/Engineer (A/E).

7.1.1 To help ensure that the agency builds a functional facility that meets its training needs, the agency should designate a representative to be the main point of contact for the A/E throughout the project, from initial planning through construction. It is helpful for the agency's representative to have sufficient time available to attend planning and design meetings with the A/E, answer A/E questions, review drawings, periodically observe construction, and attend construction progress meetings. Ideally, the agency's representative would be the chairperson of a committee that is formed to help develop design requirements and provide design feedback to the A/E.

7.1.2 The A/E should be selected as early as possible to assist with the needs assessment phase as well as continue through design and construction administration phases.

7.2 A/E Qualifications.

7.2.1 It is recommended that the agency employ an A/E with experience in fire training centers. A/E selection should use a qualifications-based (not price-based) selection system, so that credentials can be reviewed prior to employment. An A/E with the necessary qualifications for the site development and conventional building design (administrative and classroom buildings) might not have the qualifications necessary for the training props (live fire training structure, training tower, outdoor props, and mobile trainer). Specialists for props who provide this expertise internationally are available.

7.2.2 Visiting training centers that have been in operation for a minimum of 5 years should be considered in order to learn of any inherent construction or operational deficiencies and successful features. Training personnel at the training center could provide information on their A/E's performance and what aspects of the training center work well and which do not. The owner could be asked, "If you could start over and design the training center again, knowing what you now know, what would you do differently?"

7.2.3 The A/E's firm should be interviewed before the final selection is made.

7.3 The Design and Construction Process.

7.3.1 The A/E's responsibilities include needs assessment, master planning, site selection, design of the training center, production of contract documents, construction administration, and on-site observation.

7.3.2 Fire training structures, training towers, outdoor trainers, mobile trainers, and other training simulations are training props, not conventional buildings for occupancy. The A/E should work with local AHJs to ensure that each AHJ, including building officials and permitting offices, understands the nature of the use and that these structures might not require full building code compliance. The A/E could meet with or write a letter to the appropriate parties at the AHJ early in the design process to explain the nature of the project. This should help facilitate the AHJ's final review before construction begins.

7.3.3 Contractors are contractually obligated to construct the facilities in accordance with approved contract documents, which include the contract, contract terms and conditions, drawings, and technical specifications. The A/E should prepare the contract documents, and the agency should thoroughly understand them before the project is advertised for bids, to ensure that the agency's training needs have been incorporated into the design and to avoid change orders during construction. Design changes after a contract is agreed upon and especially after construction has begun can be expensive, as can retrofits after construction is complete. Therefore, it is important to consider all the potential training needs for each training structure and prop during the design phase. A system of alternatives to be added or deducted could be used to achieve more efficient and fuller use of available funds.

7.3.4 A request for bids normally precedes the issuance of the contract documents for bidding. A pre-bid conference with the A/E is necessary to establish the bidding requirements. An agency representative should be present. Once construction begins, construction progress should be observed by the A/E at stages coordinated with the work.

7.3.5 Record drawings should be prepared by the A/E using documentation provided by the contractor. These drawings should be retained after the project has been completed for use during repairs, alterations, and future expansions.

7.3.6 The agency's representative should develop a good working relationship with the jurisdiction's procurement and facilities management offices. These offices usually have a level of control over the procurement, design, and construction processes, but the individuals in these offices usually do not understand fire training or the unique nature of the facilities that are required to facilitate the training. It is usually helpful to keep in steady contact with those offices, in order to educate them and ensure that they customize their efforts according to the unique nature of the project, so that they can effectively support it.

7.4 Clerk of the Works/Owner's Project Manager.

7.4.1 A clerk of the works might be necessary, depending on the complexity of the project. The clerk should be knowledgeable in building construction and be familiar with the project contract documents. The clerk's job is to represent the building agency, attend design and progress meetings, visit the site on a regular basis, and review the progress of construction.

7.4.2 A clerk of the works is usually compensated by the building agency and is independent of the A/E and the contractor/builder. The clerk is rarely the same person as the agency's representative, because the clerk's role is related to the "nuts and bolts" of design and construction, while the role of the agency's representative is related to providing information to the A/E to ensure that training requirements will be met in the constructed training center.

7.5 Containerized Training Structures. Containerized training structures, in which one or more containers are assembled to create a training structure, whether single story or multistory, should be designed by a professional engineer to meet building code requirements for vertical loads, lateral loads, and permanent foundations.

Chapter 8 Administration/Classroom Building

8.1 General.

8.1.1 This chapter addresses the many components that should be considered when planning an administration/classroom building. *[See Figure 8.1.1(a) through Figure 8.1.1(c).]*

FIGURE 8.1.1(a) Administration Building Including Director's Office, Boardroom, Clerical Area, Instructor Offices, A/V Storage Area, Classrooms, Dining Area, Kitchen, and Student Lockers with Restrooms. *(Courtesy of Gaston College, Dallas, NC.)*

FIGURE 8.1.1(b) Administration Building A. *(Courtesy of Cheyenne Fire Training Complex, Cheyenne, WY.)*

FIGURE 8.1.1(c) Administration Building B. *(Courtesy of Glendale Regional Public Safety Training Center, AZ.)*

8.1.2 Certain components are needed only if the building is to be used for administrative purposes; others are pertinent only to a classroom building. However, if the purposes are to be combined, all of the items specified in Sections 8.2 through 8.17 should be considered. Only those items needed for the individual situation should be included to produce a viable administration/classroom building.

8.2 Offices. Office space should be provided for permanent or temporary staff, or both, which could include the officer in charge, assistant administrator, instructors, and clerical personnel. Additional office space requirements are dictated by agencies housed at the training center. Properly designed open office space could add flexibility. Closet and storage space should be included.

8.3 Conference Room. A conference room could be used for staff meetings, press conferences, and other on-site functions that need clean space, chairs, tables, and other items to support a variety of different groups and their needs.

8.4 Auditorium.

8.4.1 An auditorium could be used for classrooms, seminars, promotional ceremonies, and community activities. Movable chairs could increase the utility of this component. A balcony could add to the seating capacity. Physical fitness classes could be held in the auditorium.

8.4.2 The floor and the wall coverings could be designed to withstand indoor basic training when inclement weather precludes outside activities. A public address system should be installed. Some of the features discussed in the classroom component should be installed in the auditorium.

8.5 Classrooms.

8.5.1 Classroom size is dictated by the number of students and the type of training to be conducted. For example, hands-on training might require more space per student than training by lecture. The need for a classroom that accommodates an entire class plus several smaller, adjacent rooms for breakout sessions should be considered. *[See Figure 8.5.1(a) and Figure 8.5.1(b).]*

FIGURE 8.5.1(a) Classroom. *(Courtesy of Gaston College, Dallas, NC.)*

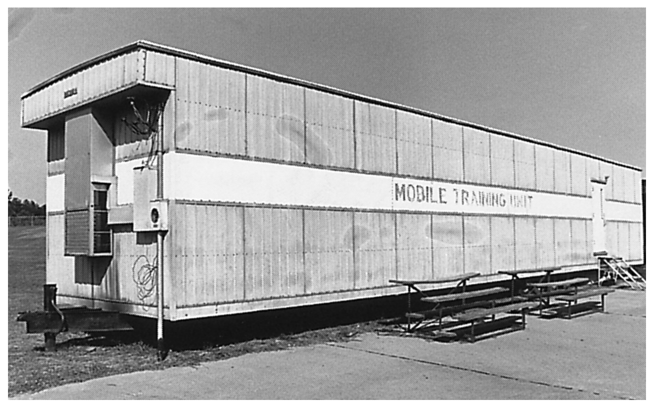

FIGURE 8.5.1(b) Mobile Training Classroom. *(Courtesy of Mississippi Fire Academy, Jackson, MS; photo by William Warren.)*

8.5.2 Movable soundproof walls could be used to vary classroom size. Adequate aisle space is necessary for proper classroom function, including space for setting down gear and practicing techniques with gear, tools, and mannequins. Heavy-duty flooring should be installed to withstand the movement of fire fighters with soiled gear.

8.5.3 The instructor should be able to control room climate and audiovisual equipment. Good lighting is important, and the use of individual controls and rheostats should be considered to vary illumination. A podium light and separate chalkboard illumination could make a presentation in a darkened room more effective. Electrical, data, and telecommunications outlets in the floor and the walls should be spaced to eliminate the use of extension cords.

8.5.4 Classroom furniture should be durable. Writing surfaces for use by the instructors and students should be provided. Folding tables that are 18 in. (450 mm) wide and stacking chairs provide flexibility in room utilization. Experience has shown that wider tables occupy space that could be better used.

8.5.5 To decrease classroom disturbances caused by noise, the following features should be explored:

(1) Doors to the room should open and close quietly.
(2) Restroom and refreshment facilities should be close to the room.
(3) Walls and partitions should be types that minimize noise from adjacent spaces.

8.5.6 Ceiling height should allow the hanging of wall screens or the placement of portable screens for good viewing. The ceiling height should be a minimum of 10 ft (3 m) as indicated by experience.

8.5.7 Air-conditioning and heating units should not be installed in the classroom due to their noise.

8.5.8 There might be a need for a "dirty" classroom that students can enter with gear that has been exposed to the fire environment.

8.5.9 An effective sound system should be installed in all classroom and assembly areas.

8.5.10 The capability for recording classroom sessions (video and audio) should be explored so that infrastructure and equipment can be incorporated.

8.5.11 The use of multiscreen, multimedia simulations should be considered when designing and planning classrooms.

8.6 Library.

8.6.1 A library should be included. The library should contain job-related periodicals and technical program books. The fire department's regulations, procedures, history, past and present orders, and national standards should be included in the library.

8.6.2 An index system should be maintained. The security of the library contents should be considered. The librarian should motivate retirees or people interested in the fire department to bequeath their fire department books to the library.

8.6.3 The services of a retired librarian might be secured on a voluntary basis. Most town libraries are glad to assist in starting a library and providing assistance.

8.6.4 If the library is large enough, individual carrels could be provided for each student.

8.6.5 Electrical, data, and telecommunications outlets in the floor and walls should be spaced to eliminate the use of extension cords.

8.7 Kitchen, Cafeteria, and Break Room.

8.7.1 Kitchens and break rooms could have the following available for staff and trainees to use:

(1) Refrigerator
(2) Stove and oven
(3) Tables and chairs
(4) Sink with disposal
(5) Vending machine(s)
(6) Coffee maker
(7) Microwave oven
(8) Dishwasher
(9) Cabinets for storage
(10) Space for trash can or trash barrel

8.7.2 Where the facility is large enough, a cafeteria service line could be installed. Food service consultants might be necessary in order to design a cafeteria that serves large numbers of people efficiently. *(See Figure 8.7.2.)*

FIGURE 8.7.2 Dining Area — Seating Capacity of Approximately 85. *(Courtesy of Mississippi Fire Academy, Jackson, MS.)*

8.7.3 Fire protection for cooking equipment should be provided according to the local building code. It might be desirable to have a separate eating area or break room for the faculty. A dining area could also be used as a classroom.

8.7.4 It might be more effective to use an outside vendor to provide meals. Vendors could provide packaged meals that are prepared off site or at the training center.

8.8 Audiovisual Support.

8.8.1 To allow an instructor to take advantage of various media, the following equipment should be available:

(1) White board
(2) Chalkboard and chalk (preferably liquid chalk)
(3) Felt board
(4) Hook and loop board
(5) Magnetic board
(6) Smart board
(7) Flat-screen monitor

8.8.2 Cameras, fixed and portable video cameras, recorders, video-editing machines, a television monitor(s), and associated equipment could provide realism for classroom instruction.

8.8.3 Projectors include the following:

(1) 16 mm movie projectors
(2) 35 mm slide projectors with a dissolve unit
(3) Overhead projectors
(4) Multimedia projectors (to include computer and DVD)

8.8.4 Compact disc and MP3 equipment, sound-sync units, portable wall or ceiling screens, and rear projectors could be beneficial adjuncts.

8.8.5 An audio jack should be installed near each equipment use station.

8.8.6 When using audiovisual equipment, the following recommendations should be considered:

(1) An extra electrical switch with a rheostat to control illumination should be provided.
(2) The rearview screen should be protected from breakage by covering it with chalkboards.
(3) Care should be taken to avoid writing on rearview screens.
(4) Permanent writing on white boards should be avoided by providing only water-soluble markers in the classrooms.

(5) The projector area should be located near a hallway so that equipment can be moved easily.
(6) Adequate distance for front and rear projectors should be provided.
(7) Stepped-down ceilings should be avoided if they will interfere with projection or viewing.
(8) HVAC should be provided in the projection room to ensure a comfortable worker environment and to avoid thermal shock to expensive electrical projector bulbs.
(9) Audiovisual equipment, lighting, and sound with remote controls should be provided.
(10) Electrical, data, and telecommunications receptacles should be installed in the floor to eliminate the use of extension cords.
(11) Projection screens should be placed so that they do not interfere with white boards or other manual writing boards.

8.9 Printing Room.

8.9.1 The facility should furnish provisions for the reproduction of printed materials. Space for a copier, computer printer, offset duplicator, collator, binding machine, transparency maker, and computers should be available. The inclusion of these machines might necessitate special electrical services. This equipment might be noisy, so an appropriate location for the printing room should be determined.

8.9.2 Proper storage of flammables and an exhaust system should be considered during the design phase. The need for space to store supplies and printed materials is essential.

8.10 Graphic Unit. A room for the preparation of graphics and other aids should be considered and should be located in a quiet area. In addition, space should be planned for instructor preparation of audiovisual programs (e.g., slides, tapes, videos).

8.11 Simulator Facility. If simulation in training is desired, space should be provided. Consideration should be given to simulation methods such as flat board mock-ups, actual equipment, videotape, simple to complex computer arrangements, and rear-screen projection.

8.12 Locker and Shower Facilities. See Figure 8.12.

8.12.1 Locker and shower facilities are usually necessary. Separate areas should be provided for males and females. These areas should include shower rooms, sinks with mirrors, and toilets. There should be adequate ventilation to reduce the water vapor accumulation from the showers.

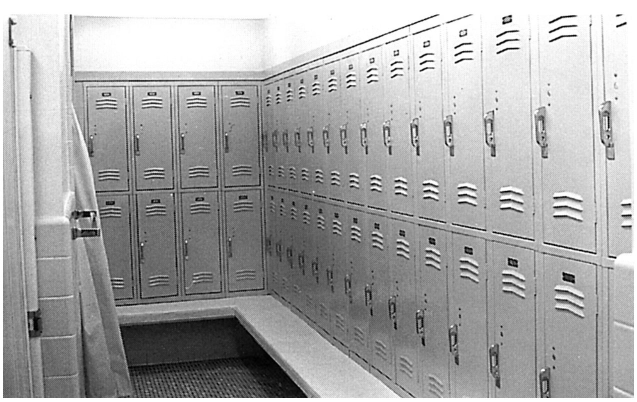

FIGURE 8.12 Student Locker Room, Which Includes Showers and Restroom Facilities. *(Courtesy of Mississippi Fire Academy, Jackson, MS.)*

8.12.2 Locker space is usually needed for instructors/staff, long-term students (e.g., recruits), short-term students (1 day to 3 days), personnel using the fitness room, and maintenance personnel. Separate areas are recommended for personnel lockers and turnout gear storage. The instructors' showers and lockers should be separate from those of the students.

8.12.3 Consideration should be given to locating locker and shower facilities in a support building close to the training grounds instead of in the clean administration/classroom building.

8.13 Cleanup and Drying Room. A cleanup and drying room for turnout gear is a necessity if students leave their gear at the training center or if turnout gear is maintained at the training center. This area should provide space for the students and instructors to clean their gear with a commercial washer and dryer or water from a hose or shower. This room should be accessible from the outside and from the locker room. Gear should be stored in a well-ventilated locker that can be locked. Special rust-resistant wire cage–type lockers might be necessary. Consideration should be given to locating the cleanup and drying room in a support building close to the training grounds instead of in the clean administration/classroom building.

8.14 Arson Lab. It is recommended that the agency responsible for arson investigation be included in the planning stage of the training center. The arson investigation force might want office space, room for sophisticated equipment, and a storage room for teaching materials. Meetings between the arson force and the fire department planners are necessary to determine the needs of the arson force.

8.15 Emergency Care.

8.15.1 Safety should be the foremost consideration in training center design. However, accidents and illnesses could occur. Space should be available for emergency care equipment.

8.15.2 A parking area for an ambulance should be provided. Transportation for multiple victims should be considered. Communications with a local hospital might help provide resources for design as well as a personnel pool for staffing.

8.16 Building Maintenance.

8.16.1 The materials used as finishes for the facility should be attractive and easy to maintain; durable materials could cut down on replacement and refinishing costs. Custodial space is needed for deep sinks, mops and wringers, and cabinets for the storage of cleaning materials and other equipment.

8.16.2 Electrical outlets should be provided in the hallways for the use of buffers and vacuum cleaners.

8.17 Observation/Control Tower.

8.17.1* Consideration should be given to the need for an observation/control tower in order to monitor various training functions from one location *(see Figure 8.17.1)*. The tower might include communications systems, fire temperature sensors, remote annunciator panels, remote cameras, and emergency fuel shutoffs. Such equipment and components should enable overall monitoring of activities and enhance operational safety. Designers should be aware of space and utility needs for control equipment associated with automated systems.

FIGURE 8.17.1 Training Area Control Tower. *(Courtesy of Mississippi Fire Academy, Jackson, MS.)*

8.17.2 The observation/control towers could work well where they are elevated and located adjacent to the training tower. Some training centers have designed this feature as the second floor above the administrative area and classroom.

8.17.3 Consideration should be given to adequate window space to maximize observation of the drill area, including observations of units responding to the training grounds from off site.

8.17.4 Consideration should be given to the fact that it might not be possible to observe all areas of the training grounds from one observation/control tower. For example, if the observation/control tower is located adjacent to the drill tower, one to three sides of the drill tower would be unable to be seen from the observation/control tower. Some training centers have stopped using the observation/control tower during training exercises due to such limitations.

8.18 Miscellaneous.

8.18.1 Public telephones should be provided.

8.18.2 A break area in which students can congregate between classes should be provided.

Chapter 9 Drill Tower

9.1 General. See Figure 9.1(a) through Figure 9.1(c).

9.1.1 There are many potential purposes for a drill tower, including the following:

(1) Basic pumper evolutions and hose evolutions
(2) Ladder drills (ground ladders, roof ladders, aerial equipment)
(3) Standpipe training
(4) Mid-rise search and rescue training
(5) Rappelling
(6) High-angle rescue
(7) Building-to-building rescue
(8) Vertical rope work, such as tripod over roof and floor openings
(9) Elevator shaft training
(10) Sprinkler training
(11) Training in the control of building utilities and fire protection systems, possibly including mock meters, panels, pumps, alarms, and control systems

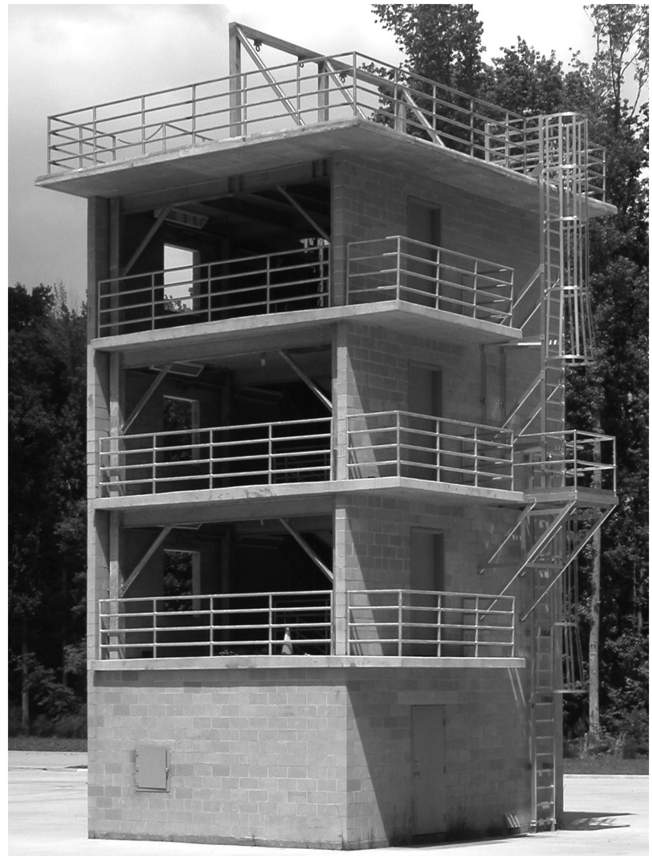

FIGURE 9.1(a) Combined Open/Closed Drill Tower. *(Courtesy of Tidewater Regional Fire Training Center, Newport News, VA.)*

9.1.2 Using a drill tower can instill confidence in trainees and further their ability to work at various heights in a skilled manner. Some law enforcement agencies ask fire training centers for permission to use the tower to train in rappel or other skills. *(See Figure 9.1.2.)*

9.1.3 Training towers are expensive to build, especially with the provision of sufficient fire resistance to withstand heat of training fires. Soot and dirt resulting from such fires could make it difficult to use the tower for other training scenarios. It could be preferable to use the tower for training evolutions that do not include live fire and to conduct interior fires in a separate training structure. If live fire training is planned for the tower, see Chapter 10.

9.1.4 The area around the drill tower should be designed to accommodate the training needs. This commonly requires paving on all four sides to allow apparatus to maneuver around the tower. Obstacles, such as the curb and gutter, sidewalks, hydrants, street signs, poles, and cables simulating overhead power lines could be added on one or more sides to provide realistic challenges.

9.2 Height. The height of the tower should be typical of the buildings found in the locale. Consideration should be given to future community development. Drill tower heights commonly range between 40 ft (12 m) and 70 ft (21 m) tall.

FIGURE 9.1(b) Enclosed Drill Tower. *(Courtesy of Tallahassee Fire Department, Tallahassee, FL.)*

FIGURE 9.1(c) Drill Tower. *(Courtesy of Naperville Fire Department, Naperville, IL.)*

FIGURE 9.1.2 Fire Training Center for Multiagency Training. *(Courtesy of Gaston College, Dallas, NC.)*

9.3 Construction. The materials used in the construction of the tower could be wood frame, reinforced concrete, steel, or other durable material. Both interior and exterior walls of the drill tower should be structurally sound to provide for the safety of personnel in training and to withstand the force of master streams. Tower components should be designed for exposure to water (from weather and hose evolutions) and changes in seasonal temperatures, both inside and out.

9.4 Dimensions.

9.4.1 The tower should be at least 20 ft × 20 ft (400 ft^2) [6 m × 6 m (36 m^2)] in floor area per level. This dimension should accommodate interior stairwell openings and allow room for fire companies to maneuver hoselines.

9.4.2 A rectangular footprint could allow for an interior, enclosed stairway and an exterior fire escape to provide two means of entrance or egress to each level. A rectangular configuration could provide more interior floor space for hose stretching practice than a square configuration. *(See Figure 9.4.2.)*

9.5 Stairways.

9.5.1 Stairways in the drill tower might be interior, exterior, or both. Stairways should provide not only a means of access between floor levels but also should simulate fireground conditions. A variety of types, widths, and situations should be realistically represented. Stairways included in the tower should be located to maximize available interior floor area. Stairway treads in the tower should be slip-resistant; open-grate treads could prevent water accumulation. The size of all stair landings should be planned to provide for personnel and equipment that must be maneuvered around corners. Floor numbers should be indicated on landings.

9.5.2 In the case of outside stairways, railings should be of sufficient height and strength to ensure protection from falls during training evolutions.

9.6 Exterior Openings.

9.6.1 Door and window openings should be sized and located to simulate situations existing in the field. Window sills should be capable of withstanding abuse from rope and ladder evolutions, with options including heavy wooden sills or concrete sills with bullnosed corners.

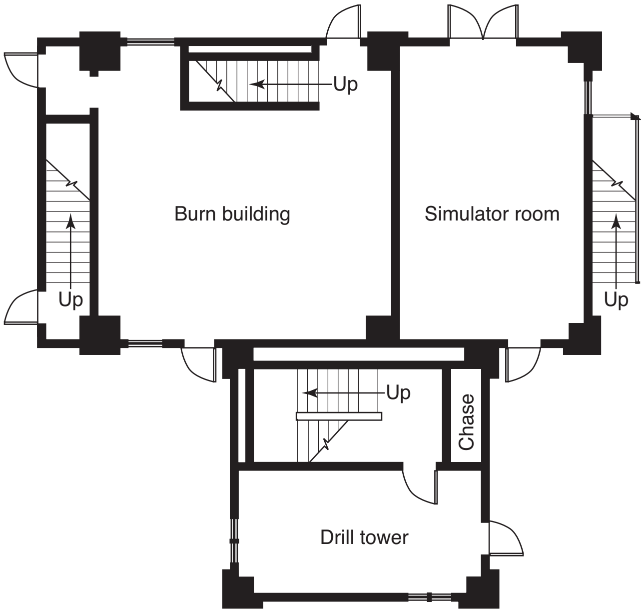

FIGURE 9.4.2 Drill Tower/Burn Building Floor Plan. *(Courtesy of Severns, Reid & Associates, Champaign, IL.)*

9.6.2 Doors and windows could be fully framed to simulate situations existing in the field or could be steel or wood shutters. Where it is not possible for the tower to include various types of doors and windows, a separate display mock-up including an example of each type should be constructed. Those areas located near ocean or river shipping facilities should take into consideration the doors or hatches found on ships.

9.7 Fire Escapes. An exterior fire escape could be placed on the tower. Railings should be high enough to safeguard a fire fighter who is operating a charged hoseline on the fire escape. The bottom of the fire escape could terminate as a stair to the ground, as a vertical ladder, or as a counterbalanced ladder. The top of the fire escape could end at the top floor, could extend to the roof as a stair, or could rise over the roof by means of a vertical gooseneck ladder. Caged vertical ladders might be desirable if they are representative of community construction.

9.8* Sprinkler and Standpipe Connections. The drill tower should include provisions for standpipe connections at all floor levels. These connections not only provide the opportunity to develop the proper procedures for connecting to, and providing a water supply for, the system but also could be utilized for simulated fire attack by fire forces operating in a high-rise building. Siamese connections should be installed and identified at ground level to accommodate auxiliary water supplies. Section valves should be installed in systems at each floor, or at selected locations, to enable the instructor to shut down only sections, not entire systems, for training purposes.

9.9 Roof Openings. Roof openings should be provided for the practice of ventilation procedures, especially if not already provided at a live fire training structure or at a ground-level roof prop. Various sized openings on flat and sloped roof surfaces could be designed into the structure so that different situations and types of roof conditions can be simulated *(see Figure 9.9)*. Safety railings should be provided for roof operations.

FIGURE 9.9 Live Fire Training Structure with Both Flat and Sloped Roofs. *(Courtesy of Nassau County Fire Service Academy, Old Bethpage, NY.)*

9.10 Coping. Where not covered by the roof, the topmost section of the walls should have a coping. Heavy wood bolted into the structure should be considered for rope work and evolutions. Stone, concrete, or other material might break away in pieces or abrade equipment and personnel.

9.11 Nets. Consideration should be given to the provision of a temporary or permanent safety net on at least one exterior side of the building, especially if rappelling is contemplated *[see Figure 9.11(a) and Figure 9.11(b)]*. A safe distance should be provided between the ground and the net to allow for movement upon impact.

9.11.1 A temporary, removable net could allow full access to the tower.

9.11.2 Springs installed between the net and the perimeter frame could increase the life of the net by lessening direct impact upon the net.

9.11.3 A ladder affixed to the tower for the mounting of the net should be considered.

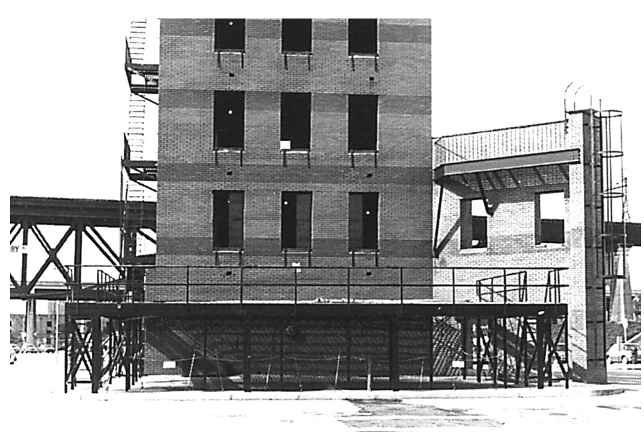

FIGURE 9.11(a) Frame of the Net. *(Courtesy of New York Fire Department Fire Academy, New York, NY.)*

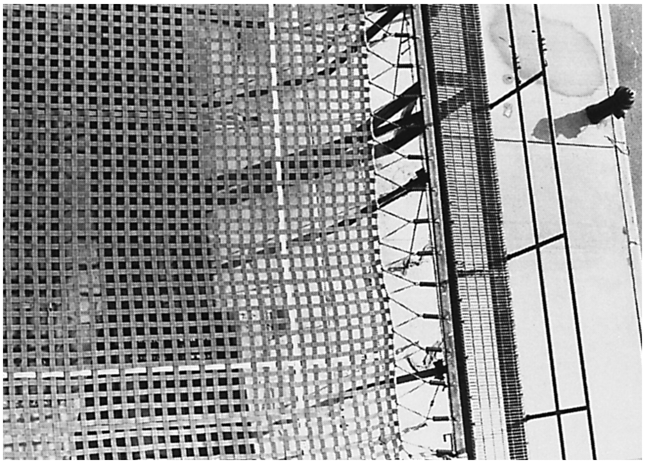

FIGURE 9.11(b) Texture of Net and Catwalk Around Net. *(Courtesy of New York Fire Department Fire Academy, New York, NY.)*

9.11.4 For a permanent net, a catwalk around the perimeter frame with a ladder to the ground could provide a standby area for the instructor and trainees.

9.12 Drains. Each floor of the tower should be equipped with floor drains or scuppers *(see Figure 9.12)*. In areas subject to freezing temperatures, conventional floor drains might not be effective. Where scuppers are used, the water discharge should be directed to areas that will not interfere with activities below the openings. Regardless of the types of drains that are selected, their installation should ensure the quick runoff of water.

9.13 Sprinkler Laboratory. The need for a laboratory from which sprinkler systems can be operated, demonstrated, and inspected should be considered. This function could be located in a dirty classroom or other facility instead of the tower.

9.14 Alarm System Laboratory. Consideration should be given to an area where several different types of operable fire alarm systems are located. This function could be located in a dirty classroom or other facility instead of the tower.

9.15 Fire Extinguishing Systems. Consideration should be given to providing an area that allows the installation of fire extinguishing systems for demonstration purposes. This function could be located in a dirty classroom or other facility instead of the tower.

9.16 Special Training Features. Special features could be included in the tower to accommodate local area needs. For example, a 36 in. (910 mm) diameter pipe could connect two floors for caisson and mine shaft rescue simulation. An elevator could be installed to be used in the simulation of elevator emergencies and for the movement of personnel and equipment. Anchor points for rope evolutions should be provided.

FIGURE 9.12 Drain Scuppers.

FIGURE 10.1(a) Two-Story Live Fire Training Structure. *(Courtesy of Cheyenne Fire Training Complex, Cheyenne, WY.)*

Chapter 10 Live Fire Training Structure

10.1 Function. See Figure 10.1(a) through Figure 10.1(d).

10.1.1 The purpose of the live fire training structure is to provide a location for training fire fighters safely in methods of interior fire suppression.

10.1.2 The live fire training structure could be designed to take into consideration the following training objectives:

(1) Fire behavior
(2) Fire spread or extension
(3) Rescue
(4) Ventilation
(5) Forced entry
(6) Laddering
(7) Various simulated occupancies similar to those found in the region
(8) Special problems

FIGURE 10.1(b) Live Fire Training Structure with Provisions for Roof Ventilation. *(Courtesy of Gaston College, Dallas, NC.)*

FIGURE 10.1(c) Multi-Story Containers Used for Live Fire Training.

FIGURE 10.1(d) Container Used for Live Fire Training.

10.2 Construction.

10.2.1 The live fire training structure could be constructed of concrete, masonry, steel, or other noncombustible materials capable of providing proper structural strength and stability. Wood and other combustible materials should be avoided. Calcium aluminate concrete ("refractory concrete") should not be used for structural slabs, beams, walls, columns, or other load-bearing structural components in live fire training structures.

10.2.2 In planning a live fire training structure, the A/E or live fire training structure designer and the user should consider the problems created by fire temperatures, thermal shock, and physical abuse inherent in live fire training. Where unprotected, concrete might crack, delaminate, or spall; masonry might crack or weaken; and steel might distort, corrode, or melt when exposed to fire temperatures and thermal shock.

10.2.3 Floors and roofs should slope at least ¼ in./ft (21 mm/m) to drains or through-wall scuppers.

10.2.4 Unless otherwise specified by the applicable building code, floors and roofs should be designed to support dead loads (self-weight plus weight of thermal linings and other permanent fixtures) plus a minimum live load of 50 lb/ft^2 (244 kg/m^2). If floors and roofs slope to interior or exterior floor/roof drains that have the potential to clog, then floor and roof structures should be designed to also support the weight of the maximum quantity of water that could accumulate on the floors or roofs if the drains clog.

10.2.5 The area around the live fire training structure should be designed to accommodate the training needs. This commonly requires paving on all four sides to allow apparatus to maneuver around the structure or paving on one side for apparatus and light-duty sidewalks or pads for foot traffic on the remaining sides. Obstacles, such as curbs and gutters, sidewalks, hydrants, street signs, poles, and cables simulating overhead power lines could be added on one or more sides to provide realistic challenges.

10.3 Burn Rooms.

10.3.1 Every burn room or compartment should have a minimum of two means of escape.

10.3.2 A ventilation system capable of removing heat and smoke to help cool burn rooms between training evolutions could be considered, if portable fans and other non-permanent solutions are not desired. If provided, the permanent ventilation system should be designed to withstand the high temperatures related to repetitive live fire training.

10.3.3 Burn areas that are fully below grade are hazardous and should be avoided. For live fire training structures where a walk-out basement configuration is impractical, basement or cellar fires could be simulated at the ground floor. An exterior stair to a second-floor landing at an exterior second-floor door could be constructed *(see Figure 10.3.3)*. Fire fighters could then enter at the second floor and simulate attacking below-grade fires by working down the interior stairs to the ground floor.

10.4 Thermal Linings.

10.4.1 Walls, floors, ceilings, and other permanent features should resist heat generated by fires and thermal shock generated when cold water is applied to heated surfaces. Training fires cause accelerated deterioration of the structure.

10.4.2 To maximize the useful life of a live fire training structure, use of thermal linings (fire-resistant coverings) should be considered in areas where flames impinge on structural surfaces and where temperatures are expected to exceed 500°F (260°C) during training for prolonged periods of time. It should be considered that heat from a fire could roll into adjacent rooms and

FIGURE 10.3.3 Burn Building with Raised Open-Grid Walkways Level with the Second Floor. *(Courtesy of New York Fire Department Fire Academy, New York, NY.)*

could bank down to a floor, causing damage away from areas of direct flame impingement. Specifications for thermal linings to protect live fire training structures should take into consideration temperature rating, thermal shock resistance, strength and resistance to physical abuse, thermal expansion and contraction, secure mounting, ability to resist repeated cycling of rapid heating and rapid cooling during training days, and ease and cost of replacing damaged sections. To provide high-temperature protection to the structural elements of the live fire training structure, the materials described in 10.4.2.1 through 10.4.2.5 could be utilized to protect the structural components.

10.4.2.1 Nonstructural precast modules made from poured calcium aluminate concrete with lightweight aggregate of high carbon content have high strength and resistance to spalling and physical abuse.

10.4.2.2 Gunning (the spraying of exposed surfaces with a calcium aluminate concrete) provides a joint-free surface that is fastened to the structural material with pins and wire mesh, with good strength and resistance to spalling and physical abuse. Its usefulness could be extended by patching if areas of gunned concrete fall out.

10.4.2.3 Masonry blocks or bricks, set in mortar at walls and without mortar at floors, provide good insulating capabilities and resistance to spalling and physical abuse. The blocks or bricks and the mortar can be conventional masonry materials or refractory materials.

10.4.2.4 Proprietary thermal linings, including exposed insulation panels and hybrid insulating systems, could be attached to the structure. Care should be taken in the choice of products: some insulation panels might not be rated for the anticipated training temperatures, and some insulation panels might crack or spall below the rated maximum temperature when subjected to fire streams or exposed to the physical abuse inherent in live fire training.

10.4.2.5 Panels made of weathering steel could be inserted into tracks on the walls and ceilings. Mounting should allow for thermal movement of the panel while maintaining secure attachment so that personnel are not injured by falling panels or mounting hardware. The selection of panel material, thickness, and air space depends on the nature, size, frequency, and duration of the fires. Since steel is not an insulator, the design of the steel thermal lining system should include a well-ventilated air space to create a means of protecting the structural elements from heat and thermal shock and/or an insulation suitable for the high heat exposure behind the steel panels.

10.4.3 To extend the life of less durable linings, a fire in a heavy gauge metal drum or crib, with metal plates welded above to prevent flame impingement on the structure, could be used as a smoke and heat simulation method. If used, the drum or crib should be raised above the floor, and the floor should be protected with bricks, patio blocks, or a steel plate. Metal drums or cribs with steel wheels installed for mobility could be considered.

10.5 Cutouts.

10.5.1 In order to permit rescue and ventilation evolutions, parts of the live fire training structure could be designed to be destroyed and replaced. These expendable sections (cutouts or chopouts) could be located in walls, ceilings, or roofs. *(See Figure 10.5.1).*

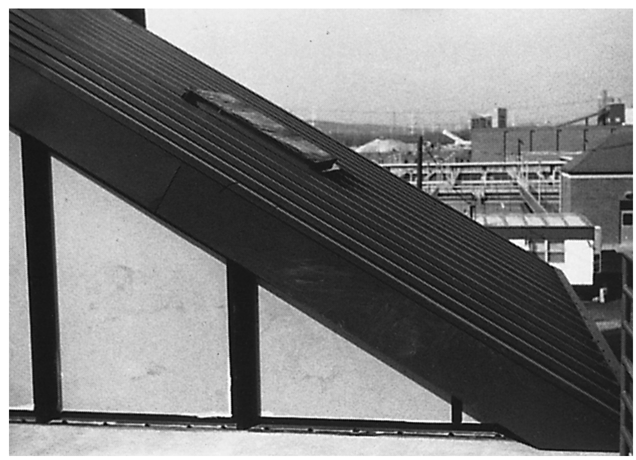

FIGURE 10.5.1 Pitched Roof with Chopout. *(Courtesy of Alexandria Fire Department, Alexandria, VA.)*

10.5.2 Consideration should be given to the fact that the cutouts could catch fire, costing money to be replaced, and requiring manpower to be reconstructed.

10.5.3 Sheetrock pull areas at wall, roof, or other locations could be considered.

10.6 Doors and Shutters.

10.6.1 Doorstops to hold doors open should be mounted on the wall behind the doors, not on the floor, to prevent hoselines from catching on them and causing damage to the hose and the doorstops.

10.6.2 Exterior doors and shutters should open outward to reduce deterioration caused by heat and to facilitate emergency egress.

10.6.3 Design of doors and shutters should consider safety, durability, and ease of maintenance, given the repeated heating and rapid cooling cycles and the rigorous use that will occur. Conventional fire-rated doors, hardware, and door closers often exhibit durability issues in live fire training structures and, where exposed to heat, could cause safety concerns, such as doors expanding into their own frames and hydraulic door closers becoming pressurized due to heat. Custom detailed doors, shutters, hardware, and hinges should be considered.

10.7 Sprinklers.

10.7.1 Sprinklers could be considered in one or more rooms, including burn rooms, for training purposes, such as teaching how to chock a sprinkler or demonstrating the effects of sprinkler flows on a fire. Fused sprinkler heads connected to a water supply could be used.

10.7.2 Open sprinklers are not reliable as a safety device in a burn room because of repeated heat exposure.

10.8 Gas-Fired Live Fire Training Structures. Gas-fired live fire training structures can provide a safe and environmentally clean method of conducting live fire burns. *(See Figure 10.8)*. Systems are available that enhance trainee and instructor safety by providing a continuously monitored live fire training environment. These systems could eliminate Class A and Class B material cleanup and possibly extend the life of the live fire training structure. These systems also could provide consistent and repeated training fires with operator control. Several vendors manufacture and install these sophisticated systems in both fixed and transportable configurations.

FIGURE 10.8 Gas-Fired Live Fire Training Structure. *(Courtesy of FDNY.)*

10.8.1 Section 10.8 applies to the design, manufacturing, and installation of new gas-fired equipment and alterations to and upgrades of existing equipment.

10.8.2 Safety Considerations. The use of flammable gases in a live fire training structure requires constant care to ensure the safety and reliability of the overall operation. Engineering expertise during design and the use of the current codes and standards recommended in Section 10.8 are essential to providing a safe training environment. It is essential that the minimum safety provisions that are specified in 10.8.2.1 through 10.8.2.19 be provided.

10.8.2.1 Facility design engineers should determine the appropriate area hazard classification for equipment rooms, burn rooms, and other spaces in order to assess electrical installation requirements.

10.8.2.2 Installations should comply with NFPA 54, *National Fuel Gas Code* and NFPA 58, *Liquefied Petroleum Gas Code*.

10.8.2.3 Per NFPA 86, *Standard for Ovens and Furnaces*, liquefied versions of flammable gas are not permitted to be piped into or utilized inside a structure and therefore cannot be used for interior live fire training.

10.8.2.4 Gas-fired live fire training systems should comply with NFPA 86, *Standard for Ovens and Furnaces*, in regard to Class B ovens or furnaces. Special emphasis should be placed on the following chapters of NFPA 86 for manufacturing, installation, testing, and certification:

(1) Chapter 6, Furnace Heating Systems
(2) Chapter 7, Commissioning, Operations, Maintenance, Inspection, and Testing
(3) Chapter 8, Safety Equipment and Application

10.8.2.5 All components of the gas-fired live fire training system should be rated and labeled for the intended use.

10.8.2.6 All wiring and equipment should be in accordance with *NFPA 70*, *National Electrical Code*, and NFPA 79, *Electrical Standard for Industrial Machinery*. It is essential that wiring and equipment installed in hazardous locations comply with the applicable requirements of *NFPA 70*.

10.8.2.7 Live fire training systems should be certified and labeled by a nationally recognized (third-party) testing laboratory (NRTL) to ensure compliance with the requirements of UL 508A, *Standard for Industrial Control Panels*; NFPA 54, *National Fuel Gas Code*; NFPA 58, *Liquefied Petroleum Gas Code*; and NFPA 86, *Standard for Ovens and Furnaces*.

10.8.2.8 Each document utilized for the certification and listing process, including those not covered in this section, should be documented on the testing report. The method of pilot and burner utilized for testing should also be included in the testing report. The manufacturer certification process should be conducted annually, and the report should indicate the next scheduled testing date.

10.8.2.9 Live fire systems should include a programmable controller or logic device in compliance with the specification set forth in NFPA 86, *Standard for Ovens and Furnaces*. If the operation for the gas-fired burner includes a manual mode, the safety devices and monitoring systems should utilize an automatic mode for safety shutdown. A manual system is not an acceptable method for interior live fire training when a gas-fired prop is being used.

10.8.2.10 The live fire system should include an intermittent pilot as described in NFPA 86, *Standard for Ovens and Furnaces*. Pilot flames should be interlocked with fuel delivery valves to prevent fuel from flowing without a confirmed pilot flame being present. Pilot flames should be continuously monitored at the point at which they ignite the main burner element. Upon loss of pilot flame, all gas supply valves should automatically close. All burners in the training compartment should be ignited directly from a confirmed and monitored flame that is designated as the primary ignition source.

10.8.2.11 A commercially designed ignition source (e.g., electric spark, hot wire, pilot burner) should be utilized with the designed intensity to ignite the air-fuel mixture. Manually lighting flammable gas fires is not permitted.

10.8.2.12 Commercial combustion safeguards are available that are equipped with pre-ignition purge, safe start check, and trial for ignition period. It is essential that a combustion safeguard with these features be utilized for each burner and pilot system. The combustion safeguard must be directly responsive to flame properties, sense the presence or absence of flame, and de-energize the fuel safety valve in the event of flame failure.

10.8.2.13 Each main and pilot fuel gas burner system should be separately equipped with at least two safety fuel gas shutoff valves in series that automatically shut off the fuel to the burner system in all of the following events:

(1) Interruption of electrical power
(2) Activation of any interlocking safety devices
(3) Activation of the combustion safeguard
(4) Operating controls
(5) Activation of manual shutdown stations

10.8.2.14 Temperature monitoring devices that display the conditions of the training environment should be installed in the burn room. Auto-temperature shutdown should be set below the limits of the personal protective equipment (PPE), to avoid injuries and equipment damage.

10.8.2.15 Combustible gas detection should be provided in training and equipment spaces. Gas detection systems should include all of the following characteristics:

(1) Be rated to operate properly within the high levels of humidity and moisture experienced under live fire training conditions
(2) Include a dryer or moisture prevention device
(3) Be designed with a rapid reaction time
(4) Utilize a pump to continuously draw samples of the environment
(5) Allow draw samples to be taken in proximity to the equipment, between burn room entrance and the burner
(6) Continuously respond and react to the dynamic changes in unburned gas levels within the training space
(7) Activate an external alarm when the level exceeds 25 percent of the lower explosive level (LEL)

10.8.2.16 Adequate air should be provided to ensure complete combustion of the gas. Depending on the facility's configuration, mechanically assisted ventilation might be necessary. Where mechanical ventilation is provided, airflow switches, buttons, and wiring should be approved for the temperature environment.

10.8.2.17 Emergency stop buttons or valves should be placed adjacent to each burn room to provide immediate shutdown in the event of an accident.

10.8.2.18 A ventilation system capable of removing heat, smoke, and unburned gas should be installed in the live fire training structure. Ventilation system design should consider the potential accumulation of unburned gases above, below, and adjacent to the fire area. The ventilation system should be interlocked with the pilot, ignition, flame safeguards, fuel delivery system, temperature sensors, gas detection system, and emergency stop switches. The ventilation system should be sized to provide a minimum of one air change per minute in the training space. A manual override should be provided in the event that the interlocking device fails.

10.8.2.19 A regularly scheduled maintenance program should be implemented based on the manufacturer's recommendations and include visual, operational, servicing, and calibration. Maintenance inspections should be conducted daily during use. It is essential that maintenance service and calibration be conducted at a minimum annually.

10.8.3 Synthetic Smoke. Gas fires do not produce smoke that obscures visibility. Synthetic smoke generators are needed where reduced visibility is a desired component of the training program. The smoke produced should not be toxic or flammable.

10.8.4 Training Mock-Ups. When mock-ups are being selected, the types of fires to which the props are to be exposed should be evaluated. Even with good design, mock-ups need periodic replacement.

• **10.9 Standard Operation Procedures.** As the agency moves to take ownership of its new live fire training structure, it should establish standard operating procedures relating to fuel load, heat during training, instructor rehab/rotation, turnout gear cleaning/rehab/rotation, and other functions as they relate to the safety of personnel and to the live fire training structure.

Chapter 11 Smoke Building

11.1 General.

11.1.1 The purpose of the smoke building is *(see Figure 11.1.1)* to acquaint trainees with the skills and abilities necessary for survival in smoke-laden atmospheres.

FIGURE 11.1.1 Smoke Building. *(Courtesy of University of Kansas, Lawrence, KS.)*

11.1.2 The smoke building should be designed to allow for the constant surveillance of the trainees by the instructor. This objective could be accomplished by having the instructor accompany the trainee, by having the instructor observe the trainee through windows, by using closed-circuit television (CCTV), or by using thermal imaging. CCTV can be used only where the smoke concentration is light or nonexistent.

11.2 Flexibility. The smoke building's interior configuration could be changeable, so that various situations could be created.

The use of modules or segments that could be quickly changed provides for additional flexibility.

11.3 Safety.

11.3.1 The smoke building should have entry points and escape hatches at frequent intervals in case of an emergency.

11.3.2 Any area of a maze that cannot be seen and reached by the instructor should have the walls or ceilings top hinged so that any section could be opened. This allows trainees to be continually accessible to the instructor.

11.3.3 Smoke rooms could have sensors built into the floor that indicate the location of the trainees.

11.3.4 Provisions should be made for the quick ventilation of the building. Consideration should be given to stopping or quickly redirecting the smoke being introduced into any given section of the smoke building, which could be accomplished by the use of blowers or exhaust fans. *(See Figure 11.3.4.)*

FIGURE 11.3.4 Smoke Building Exhaust Fan. *(Courtesy of San Antonio Fire Department, San Antonio, TX.)*

11.3.5 Communication capabilities between the instructor and trainees should be designed into the system. These capabilities could provide safeguards as well as the ability to transmit instructions to the trainees.

11.4 Smoke. Smoke used in the smoke building should be nontoxic and of a known composition. Specially designed mechanical equipment could be installed in the smoke building to produce nontoxic smoke for training purposes.

Chapter 12 Combination Buildings/Training Structures

12.1 General.

12.1.1* At some training centers, because of a lack of available space or funds, individual structures for drill tower functions, live fire training, smoke training, or any combination thereof, might not be built. In these instances, a combination training structure that embraces all of the desirable functions in one structure could be constructed. Consideration should be given to the detrimental effects that any single function could have on the facility, equipment, or other functions. *[See Figure 12.1.1(a) through Figure 12.1.1(c).]*

12.1.2 Certain functional combinations are, by their nature, more compatible than others. Consideration might be given to combining functions, keeping in mind that the live fire

FIGURE 12.1.1(a) Combination Building. *(Courtesy of Reading-Berks Fire Training Center, Berks County, PA.)*

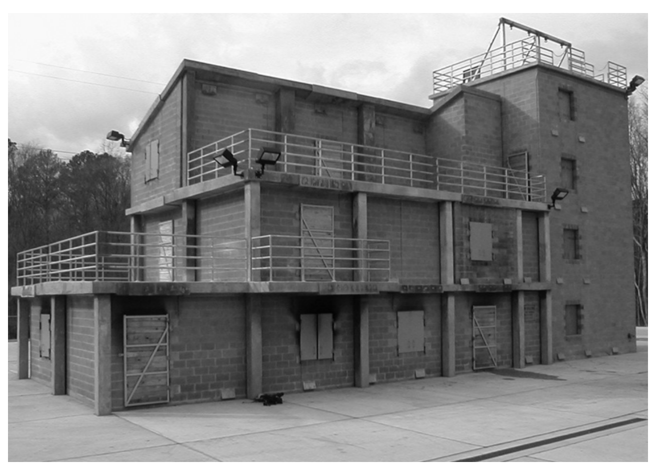

FIGURE 12.1.1(b) Combination Live Fire Training Structure and Drill Tower. *(Courtesy of Virginia Beach Fire Training Center, Virginia Beach, VA.)*

FIGURE 12.1.1(c) Multipurpose Drill Building. *(Courtesy of St. Louis Fire Department, St. Louis, MO.)*

training function usually results in faster-than-normal deterioration of the facility.

12.1.3 If adequate protection from water and smoke damage is provided, classroom facilities could be combined with the drill tower and smoke training functions into one building. Other combinations are possible, depending on which functions are required or desired, including fire station and functions performed by other divisions of the department. Facility planners have found that the limiting factors include available space and funding. *[See Figure 12.1.3(a) and Figure 12.1.3(b).]*

FIGURE 12.1.3(a) Fire Apparatus Building with Classroom, Repair and Maintenance Room, Shower Facilities, General Storage, and Apparatus. *(Courtesy of Guilford Tech Community College, Greensboro, NC.)*

FIGURE 12.1.3(b) Combination Building Housing Classrooms, Mask Service Unit, Garage, and Kitchen. *(Courtesy of Burlington County Fire Academy, Burlington County, NJ.)*

Chapter 13 Outside Activities

13.1 General. Ample outside space should be provided for a variety of uses, including auto extraction, ventilation, forcible entry, drafting, exterior fires, property conservation, and other training scenarios. Specific layouts would be needed for permanent installations for training in the areas discussed in this chapter. *(See Figure 13.1.)*

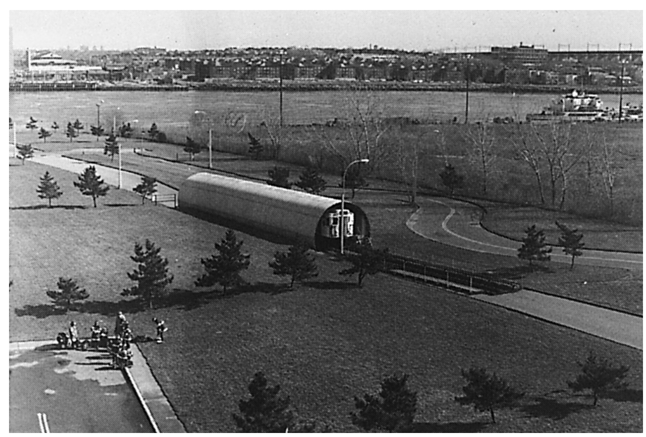

FIGURE 13.1 Outdoor Training Scenario: Transportation Problem — Train in Tunnel. *(Courtesy of New York Fire Department Academy, New York, NY.)*

13.2 Flammable Liquids and Flammable Gases.

13.2.1 The flammable liquid burn area should be located remotely from the administration/classroom building to prevent smoke from entering the building and to minimize noise and other inconveniences. Fencing should be provided for safety.

13.2.2 Pits to simulate fuel spills could be constructed in various sizes and shapes. Obstructions could be built into these pits to make extinguishment more difficult. Pit aprons should be made of concrete, crushed stone, or iron ore slag. *(See Figure 13.2.2)*

FIGURE 13.2.2 Flammable Liquid Pond. *(Courtesy of District of Columbia Fire Department, Washington, DC.)*

13.2.3 Other gas-fired props (combustible gas) might include the following:

(1) Aboveground tanks
(2) Overhead flanges
(3) "Christmas trees"
(4) Vehicle fire, including car, bobtail truck, other
(5) Dumpster fire
(6) Aircraft fire
(7) Rail fire
(8) Gas main break
(9) Liquefied petroleum gas facilities
(10) Other industrial fire scenarios

13.2.4* Consideration should be given to the water supply, fuel supply, fuel pumping capability, drainage, and environmental regulations. Coordination with environmental protection agencies is essential to ensure that the area is designed to applicable standards. Management of liquid fuels could result in lower fuel consumption, as well as a lower volume of contaminated runoff. Management could be accomplished by metering the quantity of fuel available, by mixing water with the fuel, and by using devices that atomize or restrict fuel flow. *[See Figure 13.2.4(a) through Figure 13.2.4(c).]*

13.2.5 If flammable liquid or gas is fed to an area, the flow should be controlled by quick shutoff valves. In case of an emergency, an instantaneous shutdown is necessary.

13.2.6 Gas-Fired Props (Combustible Gas).

13.2.6.1 General. Gas-fired burn props could provide a safe and environmentally clean method of conducting live fire burns. Systems are available that enhance trainee and instructor safety by providing a continuously monitored live fire training environment. These systems could eliminate Class A and Class B material cleanup and possibly extend prop life. These systems could provide consistent and repeated training fires with operator control. Several vendors manufacture and install these sophisticated systems in both fixed and transportable configurations.

13.2.6.2 Section 13.2 applies to the design, manufacturing, and installation of new equipment and to alterations and upgrades of existing equipment.

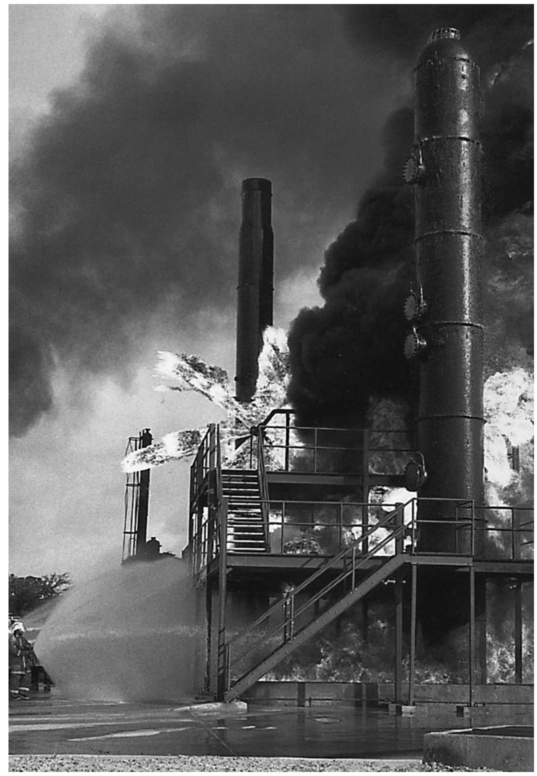

FIGURE 13.2.4(a) Chemical Complex Fire Training Aid. *(Courtesy of Fire Protection Training, Texas A & M University, College Station, TX.)*

FIGURE 13.2.4(b) Rail Car Compressed Gas Fire. *(Courtesy of Westchester County, NY.)*

13.2.6.3 Safety Considerations. The use of flammable gases requires constant care to ensure the safety and reliability of the overall operation. Engineering expertise during design and the use of current codes and standards recommended in this section are essential to providing a safe training environment. It is essential that the minimum safety provisions specified in 13.2.6.3.1 through 13.2.6.3.13 be provided.

FIGURE 13.2.4(c) Portable Fire Extinguisher Training Area. *(Courtesy of Nassau County Fire Service Academy, Old Bethpage, NY.)*

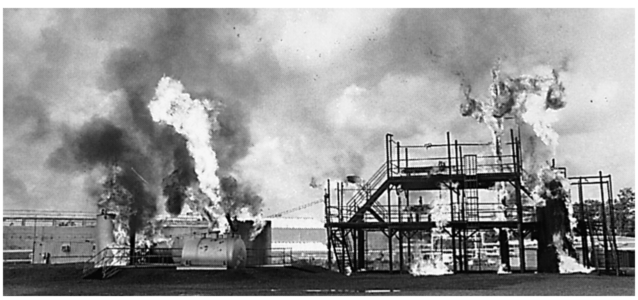

FIGURE 13.2.4(d) Three-Level Chemical Complex and Tank Farm. *(Courtesy of Fire Training Facility, Texas Eastman Co., Longview, TX.)*

FIGURE 13.2.4(e) Hazardous Material Spill Training Aid. *(Courtesy of Fire Protection Training, Texas A & M University, College Station, TX.)*

13.2.6.3.1 Installations of liquefied petroleum gas props should be equipped with all safety features described in NFPA 54, *National Fuel Gas Code,* and NFPA 58, *Liquefied Petroleum Gas Code.* Vapor and liquefied versions of flammable gas are permitted to be utilized for exterior gas-fired training provided the installation is in compliance with these codes, respectively.

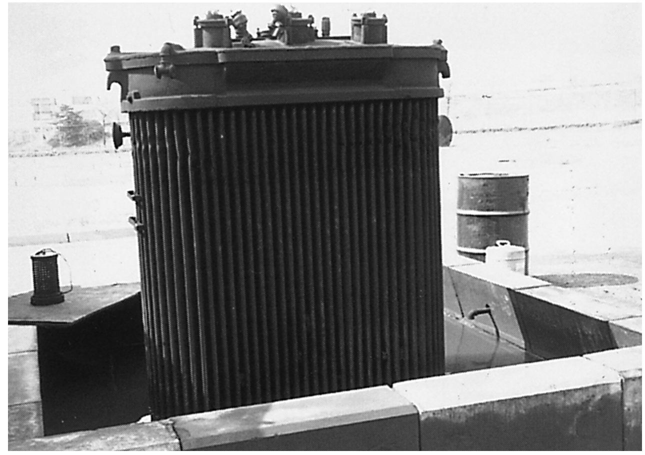

FIGURE 13.2.4(f) Flammable Liquid–Cooled Electric Transformer Mock-Up.

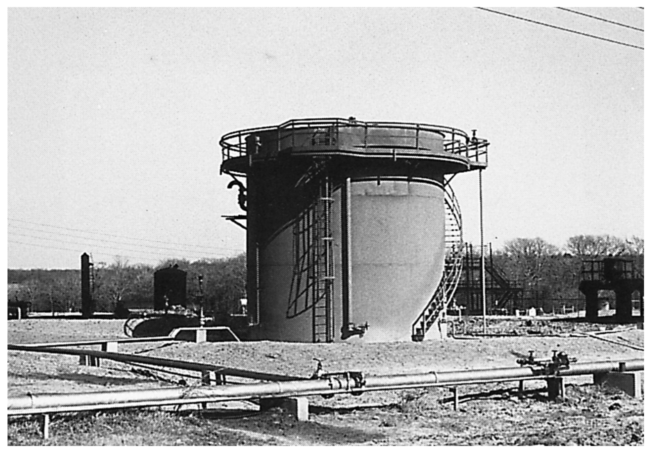

FIGURE 13.2.4(g) Vertical "Floating Roof" Fuel Storage Tank Fire Training Aid. *(Courtesy of Fire Protection Training, Texas A & M University, College Station, TX.)*

13.2.6.3.2 Gas-fired live fire training systems should comply with NFPA 86, *Standard for Ovens and Furnaces*, in regard to Class B ovens or furnaces. Special emphasis should be placed on the following chapters in NFPA 86 for manufacturing, installation, testing, and certification:

(1) Chapter 6, Furnace Heating Systems
(2) Chapter 7, Commissioning, Operations, Maintenance, Inspection, and Testing
(3) Chapter 8, Safety Equipment and Application

13.2.6.3.3 All components of the gas-fired live fire training system should be rated and labeled for the intended use.

13.2.6.3.4 It is essential that all wiring and equipment be in accordance with *NFPA 70, National Electrical Code,* and NFPA 79, *Electrical Standard for Industrial Machinery*. It is essential that wiring and equipment installed in hazardous locations comply with the applicable requirements of *NFPA 70*.

13.2.6.3.5 Live fire training systems should be certified and labeled by a nationally recognized (third party) testing laboratory

(NRTL), to ensure compliance with the requirements of UL 508A, *Standard for Industrial Control Panels*; NFPA 54, *National Fuel Gas Code*; NFPA 58, *Liquefied Petroleum Gas Code*; and NFPA 86, *Standard for Ovens and Furnaces*.

13.2.6.3.6 Each document utilized for the certification and listing process, including those not covered in this section, should be documented on the testing report. The method of pilot and burner utilized for testing should also be included in the testing report. The manufacturer certification process should be conducted annually, and the report should reflect the next testing date required.

13.2.6.3.7 Live fire systems should include a programmable controller or logic device in compliance with the specification set forth in NFPA 86, *Standard for Ovens and Furnaces*. If the operation for the gas-fired burner includes a manual mode, the safety devices and monitoring systems should utilize an automatic mode for safety shutdown. A manual system is not an acceptable method for interior live fire training when a gas-fired prop is being used.

13.2.6.3.8 The live fire system should include an intermittent pilot as described in NFPA 86, *Standard for Ovens and Furnaces*. Pilot flames should be interlocked with fuel delivery valves to prevent fuel from flowing without a confirmed pilot flame being present. Pilot flames should be continuously monitored at the point at which they ignite the main burner element. Upon loss of pilot flame, all gas supply valves should automatically close.

13.2.6.3.9 A commercially designed ignition source (e.g., electric spark, hot wire, pilot burner) should be utilized with the designed intensity to ignite the air-fuel mixture. Manually lighting flammable gas fires is not permitted.

13.2.6.3.10 Commercial combustion safeguards are available that are equipped with pre-ignition purge, safe start check, and trial for ignition period. A combustion safeguard with these features should be utilized for each burner and pilot system. The combustion safeguard should be directly responsive to flame properties, sense the presence or absence of flame, and de-energize the fuel safety valve in the event of flame failure.

13.2.6.3.11 It is essential that each main and pilot fuel gas burner system be separately equipped with at least two safety fuel gas shutoff valves in series that automatically shut off the fuel to the burner system at minimum in all of the following events:

(1) Interruption of electrical power
(2) Activation of any interlocking safety devices
(3) Activation of the combustion safeguard
(4) Operating controls
(5) Activation of manual shutdown stations

13.2.6.3.12 All props that use pressure to move fuel to the fire should be equipped with remote fuel shutoffs outside of the safety perimeter but within sight of the prop and the entire field of attack for the prop.

13.2.6.3.13 A regularly scheduled maintenance program should be implemented based on the manufacturer's recommendations that include visual, operational, servicing, and calibration. Maintenance inspection should be conducted daily during use. Maintenance service and calibration should be conducted at a minimum annually.

13.3 Electrical. Electrical safety could be taught by constructing various electrical wiring systems *(see Figure 13.3)*. Some electrical problems that might be addressed are downed wires, vaults, transformers, meters, and main disconnects. A local

FIGURE 13.3 Simulated Overhead Power Lines near Training Structure for Laddering Skills. *(Courtesy of Reading-Berks Fire Training Center, Berks County, PA.)*

utility company could be requested to participate in the planning phase of this section of the training center.

13.4 Drafting Pit.

13.4.1 A drafting pit could be desirable to facilitate the training of pump operators and to test pumper apparatus. *[See Figure 13.4.1(a) and Figure 13.4.1(b).]* In general, a capacity of at least 20,000 gal (75,700 L) of water is necessary, assuming water will be recycled to the pit. Where the pit also serves as the sole supply of water for training, larger quantities could be

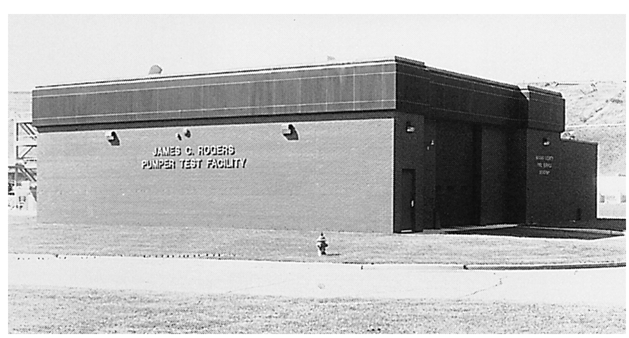

FIGURE 13.4.1(a) A Drafting Pit for Year-Round Testing, This Pump Testing Area Could Be Used in Cold Weather. *(Courtesy of Nassau County Fire Service Academy, Old Bethpage, NY.)*

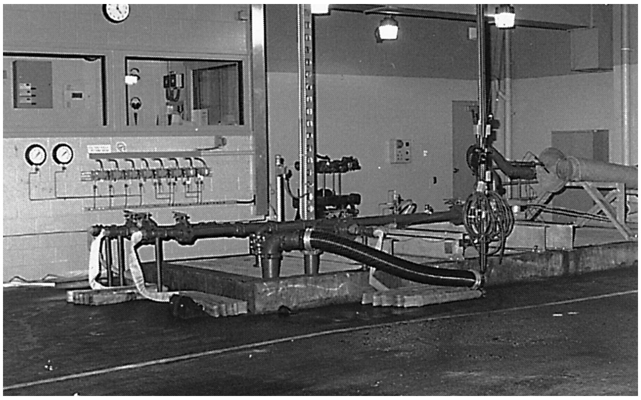

FIGURE 13.4.1(b) This Drafting Pit Inside Area Is Large Enough for a Quint and Has a Soundproof Control Room for Observers. *(Courtesy of Nassau County Fire Service Academy, Old Bethpage, NY.)*

needed. The size of the pit and the collection tube configuration should be designed to reduce or minimize the heating of the water, turbulence, and air entrapment.

13.4.2 The pit should be proportioned so that the water will be at least 4 ft (1.2 m) deep, with the top surface of the water no more than 10 ft (3 m) below the pump intake (preferably higher), so that the water level will not drop lower than 10 ft (3 m) below the pump intake during pump operations. Pit proportions should match the anticipated apparatus that would be used, including apparatus that is anticipated for future use.

13.4.3 The pit should have at least one 6 in. (0.15 m) diameter dry hydrant with an intake strainer at the bottom of the dry hydrant, close to the bottom of the pit, and at least 2 ft (0.6 m) below the top surface of the water. If large flows are anticipated, two dry hydrants should be considered.

13.4.4 The pit should have access openings at the top, both for maintenance personnel and for suction hard sleeves. The access openings should have hinged covers that are capable of supporting personnel.

13.4.5 There should be a collection tube or hood to direct pumper discharge back into the pit *(see Figure 13.4.5).* The tube or hood configuration should allow for handlines to be held in place by a stand or other means, so that personnel do not have to hold handlines during pump operations. Baffles should be provided in the pit to minimize turbulence.

FIGURE 13.4.5 Outdoor Drafting Pit with Collection Hood. *(Courtesy of Woodman Road Fire Training Center, Henrico County, VA.)*

13.4.6 Instrumentation should be placed in a protected location. It might be advantageous to locate instruments in an area removed from apparatus noise. In this case, an intercom system might be needed between the instrumentation area and the pump operator. Where portable instrumentation could be used, provisions should be made for the units.

13.4.7 Paving adjacent to the drafting pit should be concrete, to support apparatus weight and to be resistant to exhaust heat during prolonged pump operations.

13.5 Apparatus Driver Training Course.

13.5.1 The design features of apparatus driver training courses should challenge the abilities of the student driver based on the customary or anticipated problems encountered in a particular jurisdiction and by matching the challenges to practical situations. In addition, course components should reflect national professional qualification standards for driver training certification. *(See Figure 13.5.1)*

FIGURE 13.5.1 Example of a Driver Training Course.

13.5.2 Limited resources, high property values, and availability of sufficient property adjacent to the proposed training center could impact the design features of the driver training course. Resource pooling with other departments or agencies should be explored as a means to overcome these obstacles.

13.5.3 The design components should be agreed upon in advance and time-sharing agreements reached prior to the commitment of funds. Agreements between parties should be resolved at least by the issuance of a "letter of understanding" or, preferably, by a formal contract.

13.5.4 Incorporating driver training space within the drill field area of the training center could be a practical solution to budgetary or property concerns, but this arrangement could necessitate setting priorities that could result in a decrease in driver training activities.

13.5.5 An arrangement that should be considered is a combination of two separated yet interconnected areas, such as a drill field incorporating the training structures and props and a separate driver training area with roadways, hills or inclines, and lane markers. These two areas should be interconnected, so that movement from one to the other is accomplished readily and without interference; however, they should be separated in some manner, so that entry from one area to the other requires a deliberate effort, thus protecting the activities in progress in each area at any given time. A live fire training structure, for instance, would serve as such a separation barrier.

13.5.6 Student, staff, and visitor parking areas should be segregated from driver training areas and should be posted with signs or located within some physical barrier or fence. Apparatus involved in driver training exercises should not enter parking areas, and areas of training should be posted with signs to avoid accidental access by unauthorized vehicles.

13.5.7 The components of a driver training course should incorporate the following basic driving maneuvers as a minimum:

(1) Serpentine
(2) Alley docking
(3) Opposite alley pull-in
(4) Diminishing clearance
(5) Straight-line driving
(6) Backing
(7) Station parking
(8) Confined space turnaround

13.5.7.1 The basic components listed in 13.5.7 could be accommodated with a site area of 300 ft × 200 ft, or 1.4 acres (91 m × 61 m). This area size could allow for driver training paving to encircle training props, such as vehicle extrication or hazmat spills, if site constraints limit the ability to segregate driver training from other training props.

13.5.7.2 In addition to the basic components, a hill-incline ramp, with sufficient angle to test the student driver's ability to "hold" apparatus, or to demonstrate stopping on an incline, could be valuable. For those training centers with ample resources and space, a skid pad could be valuable for skid control and braking exercises.

13.5.8 Whether safety cones are used to mark the course (this could accommodate variances in apparatus size and flexibility in time-sharing with other agencies) or permanent obstacles are erected, the course design should depend on the following:

(1) Knowledge of the standard width of streets and intersections in the geographical location
(2) Specifications for highway and road construction in the area served, with emphasis on weather and climate conditions
(3) Length, type, and specifications (turning ratio and wheel base) for new, old, and anticipated apparatus
(4) Snow removal and grass-cutting maintenance
(5) Storm drainage of driving track and skid pad
(6) Weight and size of vehicles

13.6 Hazardous Materials Containment and Decontamination Areas.

13.6.1 An area dedicated to hazardous materials training should be considered. Features could include tanker trucks (on wheels, on sides, or both), rail cars (on tracks, on sides, or both), drums, and other vessels to simulate leaks and spills; and paving with curbs and drain inlets to accommodate training of diverting, damming, and diking.

13.6.2 An area dedicated to hazardous materials training could also be used for training in hazmat suits and using decontamination techniques.

13.7 Outside Classrooms.

13.7.1 Outside classrooms, resembling picnic pavilions constructed of wood or metal, with benches for seating, could be useful for providing covered shelter for students and instructors near the training props, so that personnel do not have to relocate to the administration/classroom building for various functions. An outside classroom could be used as a dirty classroom for briefing before a training evolution and debriefing afterwards, and as a place to rehabilitate and rehydrate between evolutions. It could also be used for emergency shelter during a storm.

13.7.2 Features that should be considered for outside classrooms include the following:

(1) Open (no walls) on three sides, with wall at fourth side (preferably at the side with the greatest sun exposure for hotter climates)
(2) White board on the wall for use by instructors
(3) Fans and misting fans
(4) Storage rooms, rest rooms, or both, behind the wall
(5) Water fountain(s), vending machines, or both

13.8 Technical Rescue Team Functions.

13.8.1 Collapse Rescue/Urban Search and Rescue (USAR) Training.

13.8.1.1 Although collapse rescue/USAR training could require large site areas and funding, collapse rescue training areas should be considered. Training functions could include the following:

(1) Basic concrete cutting prop
(2) Basic support/balancing prop
(3) Partially collapsed building prop
(4) Rubble pile (complete building collapse prop)

13.8.1.2 Collapse rescue props should be designed to ensure the safety and stability of the prop structure, especially when students are moving, bracing, and shoring components within the prop.

13.8.2 Trench Rescue.

13.8.2.1 Trench rescue props should be designed to prevent actual trench collapse during training. One method that has been used successfully is to construct two parallel concrete retaining walls within a hillside. Soil located between the walls could be excavated, with shores installed against the concrete walls. The concrete walls should be designed to prevent the hillside soil from collapsing into the trench excavation. The training area should have a walk-out condition at one end to enhance safety. The top of the trench should have fall protection (grating covering the trench or guardrails around the trench) for times when the trench prop is not in use.

13.8.2.2 Trench configurations could include a straight-run trench, T-intersections, and cross-intersections.

13.8.3 Confined Space.

13.8.3.1 Confined space props could include horizontal and vertical pipes, manholes, maze rooms, tanks, and other scenarios. These simulated functions could be interconnected to increase travel distances.

13.8.3.2 There should be numerous means of entry and egress. Confined space props should not be constructed fully below grade. Confined space props that are partially below grade should have a walk-out condition at one side plus additional entry and egress points for students to enter and instructors to instruct and assist students.

13.9 Mock City.

13.9.1 Mock cities typically consist of training props that simulate streets and various buildings that might be found in the region surrounding the training center. A mock city could be used by fire departments and other agencies for various training exercises (for example, police departments could use it for arrest, search and seizure, crowd control, hostage, and other scenarios). In addition, a mock city could be used by various public safety and governmental agencies simultaneously to train for responding to major events, such as natural disasters, terrorist attacks, and riots.

13.9.2 The mock city could consist of a road network connecting various structures. The roads should be realistic, including the paving, curb and gutter, sidewalks, poles, signs, traffic signals, hydrants, and other features commonly found in roadways.

13.9.3 The structures in a mock city should be unoccupied training props and could simulate houses, apartments, schools, gas stations, banks, motels, offices, or other buildings. The structures should be designed to be durable for repeated training scenarios. A live fire training structure, a drill tower, partially collapsed buildings, or combinations thereof, could be incorporated into the mock city, as could a rubble pile (fully collapsed structure), a vehicle extrication area, a trench rescue simulator, and tanker trucks simulating hazmat spills.

13.10 Fire Behavior Lab ("Flashover Container").

13.10.1 A fire behavior lab should be considered for the teaching of basic fire behavior (but not fire attack or other training scenarios). *(See Figure 14.1.)*

13.10.2 The fire behavior lab should have two means of egress plus elevation offsets and ventilation hatches designed to demonstrate various phases of fire.

13.10.3 Several vendors manufacture fire behavior labs in both fixed and transportable configurations.

13.11 Aircraft Fire Suppression and Rescue.

13.11.1 If the typical Aircraft Rescue and Fire Fighting (ARFF) vehicle on the airport runway holds 1500 gal (5677 L) of water and 150 gal (568 L) of Aqueous Film Forming Foam (AFFF), the replenishment means is a fixed water hydrant located at the midway point of the runways. If a hydrant flow capacity is 250 gpm (946 L/min) and if the average time to drive from the approach or the departure end of any runway to the midpoint is 2 minutes, then a reasonable time to replenish a vehicle and return it to operation from the end of the runway is 18 minutes. This allows 2 minutes to drive to the hydrant, 4 minutes to connect to the hydrant, 7 minutes to fill the water tank, 3 minutes to disconnect from the hydrant, and 2 minutes to drive back to the end of the runway. This might be considered a reasonable amount of time to replenish the vehicle at this particular airport, if additional vehicles are available to continue support at the emergency scene, but it might be entirely too slow for an airport where this ARFF vehicle is the only vehicle available to support an aircraft scene. In this case, the replenishment plan should be reevaluated and adjusted to reduce the time required.

13.11.2 One of the primary tasks of rescue operations is for the airport fire fighter to maintain a habitable environment around the fuselage and to assist with aircraft evacuation by stabilizing slide chutes and assisting and controlling the evacuees.

13.11.2.1 Training and evaluation of this task can be accomplished using actual aircraft or mock-ups.

13.11.3 Pre-Incident Planning. Pre-incident planning directly affects a fire department's ability to provide quality resource protection. Fire fighters must be trained, competent, and certified to execute pre-incident plans. The live fire training program focuses on a fire fighter's ability to work as a team member during realistic and challenging training events.

13.11.4 Simulator Requirements. The following basic designs for an aircraft fire/rescue training simulator challenge fire fighters and result in increased protection for airports and airlines. Simulators can be constructed with low-cost materials that are usually available in maintenance yards or public works departments. Simulators can be equipped to use hydrocarbon fuels, such as Jet A, or clean-burning propane. Figure 13.11.4(a) through Figure 13.11.4(h) illustrate such a simulator. These mock-ups were developed for the users' information by U.S. Air Force HQ AFCESA/DEF, Tyndall AFB, FL.

(1) Running fuel fire: This requirement is met by allowing a continuous, small stream of aircraft fuel to flow from the engine simulator into a catch basin. The fuel is ignited, resulting in a fire at the lead source. The fuel burns as it falls through the air and ignites the surface fire in the catch basin. *[See Figure 13.11.4(b).]*
(2) Interior aircraft fire: The fuselage and cabin section should be constructed of steel frames and heavy metal skin that will withstand heat and rapid cool down. The simulator should be 30 ft to 40 ft (9.14 m to 12.19 m) in length to allow a realistic cabin fire-fighting exercise. The scenario includes burning Class A materials in the simulator to create the conditions expected with an interior aircraft fire. *[See Figure 13.11.4(f) and Figure 13.11.4(g).]*
(3) Auxiliary power unit (APU) fire: The APU fire is created by burning fuel within a 6 in. (15.24 cm) steel pipe, suspended from the wing. This addition is a reasonable simulation of both the intake and exhaust ports. *[See Figure 13.11.4(b).]*
(4) Wheel assembly fire: Salvaged tire rims can be welded onto the number 2 wing support. Fuel can flow from above or through a pressurized device around the rims, or spray fuel on the rims can create a typical aircraft tire assembly fire. *[See Figure 13.11.4(a) and Figure 13.11.4(g).]*
(5) Ventilation of doors and hatches: This design provides for both normal and emergency means of entry and egress. Normal entry is made through a hinged door, mounted forward of the wing. Emergency entrance is made through two overwing openings and one aft door. All emergency openings are framed on the sides and bottom by angle iron. This procedure allows for sections of corrugated metal to be dropped into place and removed after use. An additional hatch has been added to the top of the fuselage to simulate military aircraft and provide for vertical ventilation. *[See Figure 13.11.4(d) and Figure 13.11.4(h).]*
(6) Access through normal and emergency hatches for rescue
(7) Passenger extraction and use of rescue equipment: Access to simulated passengers is possible by using mechanical rescue equipment to force openings in the corrugated metal panels. These sections can be forced or cut with pneumatic cutting devices or power saws. These metal sections can be secured with pins to allow the realistic use of other hydraulic rescue equipment. *[See Figure 13.11.4(e) and Figure 13.11.4(f).]*

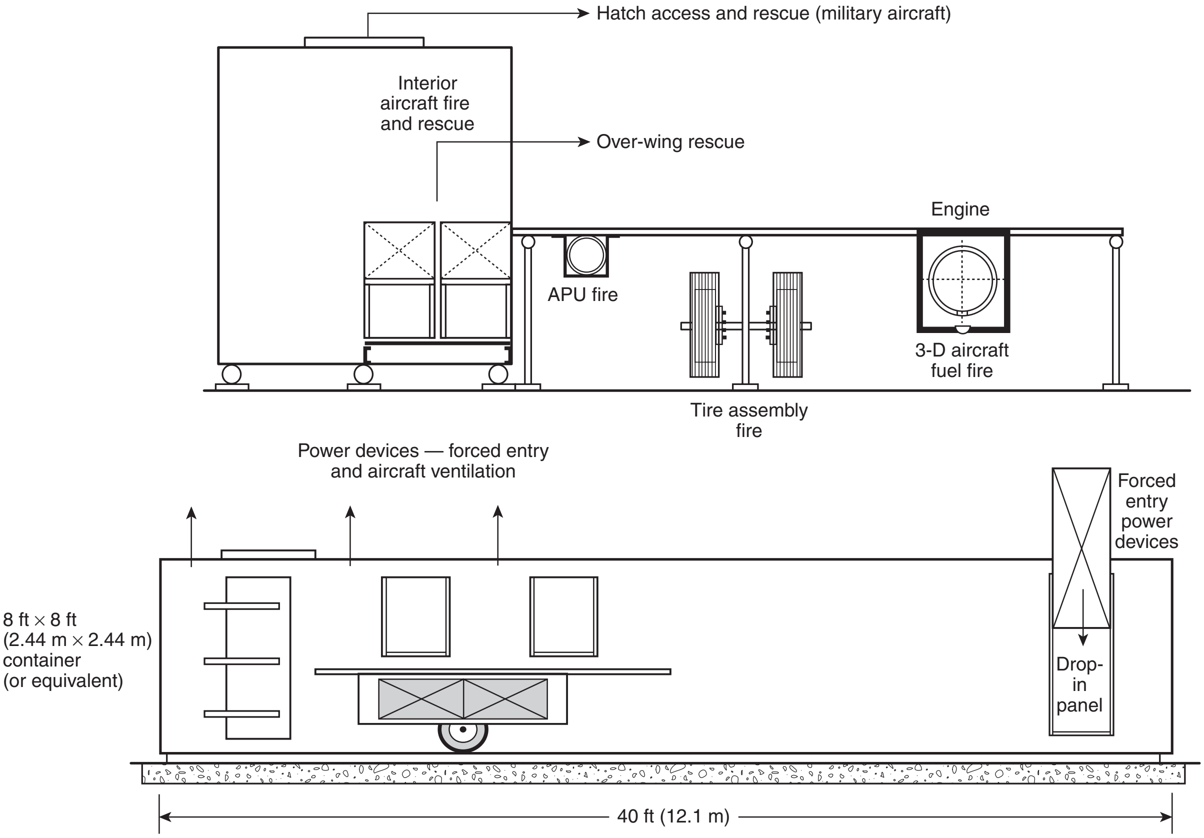

FIGURE 13.11.4(a) Aircraft Fire Suppression and Rescue Live Fire Training Mock-Up.

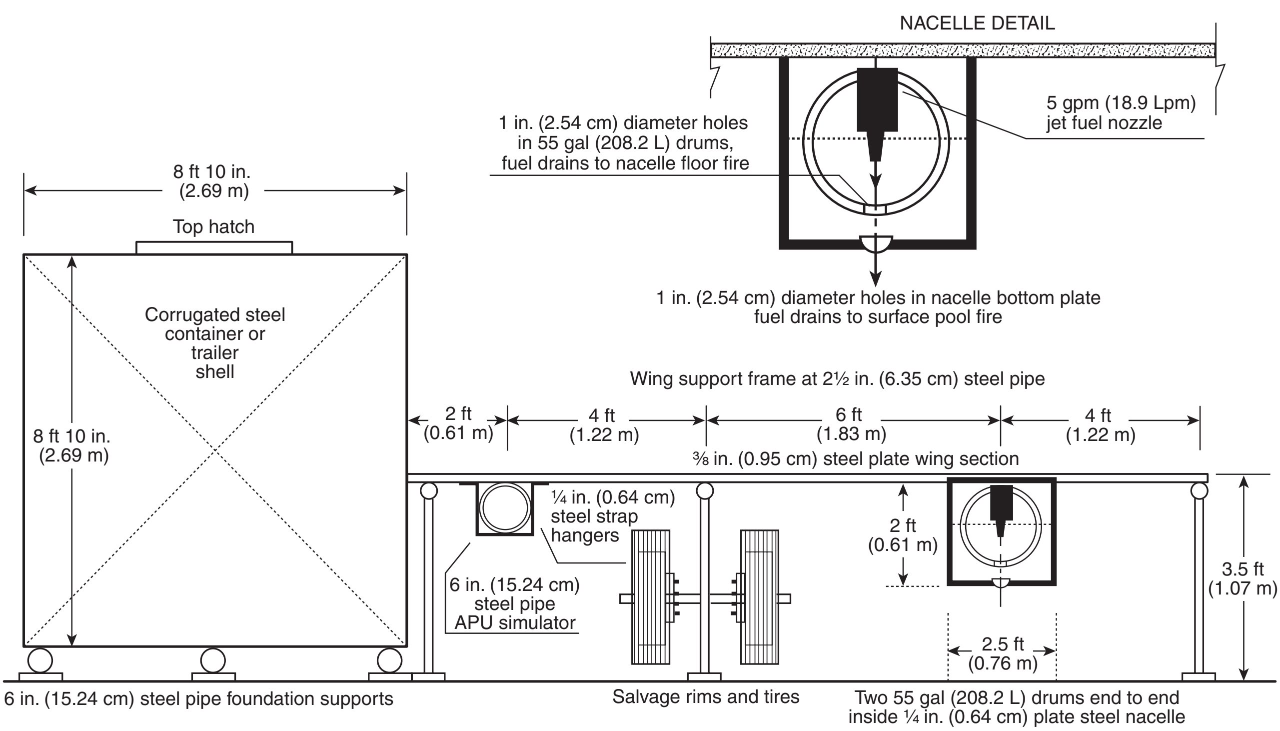

FIGURE 13.11.4(b) Aircraft Fire Suppression and Rescue Live Fire Training Mock-Up (front view).

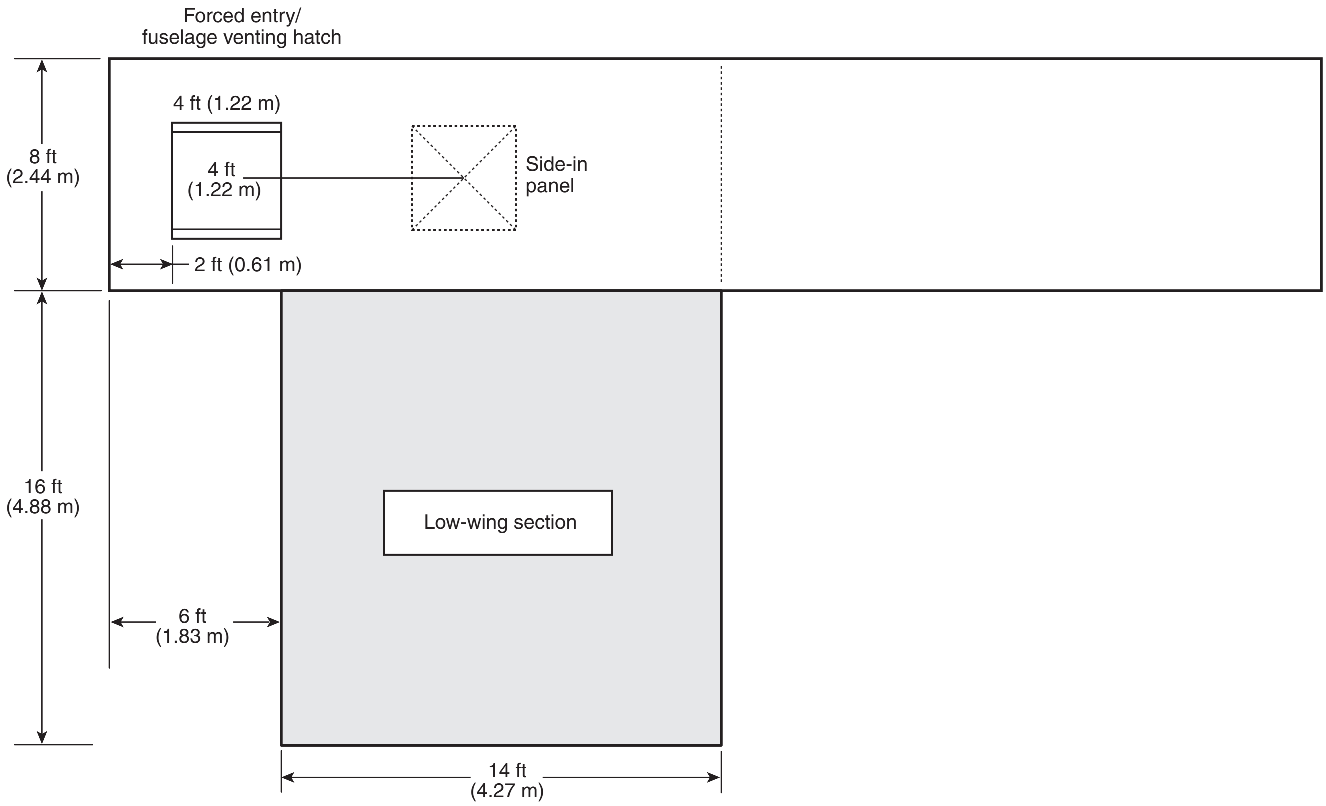

FIGURE 13.11.4(c) Aircraft Fire Suppression and Rescue Live Fire Training Mock-Up (top view).

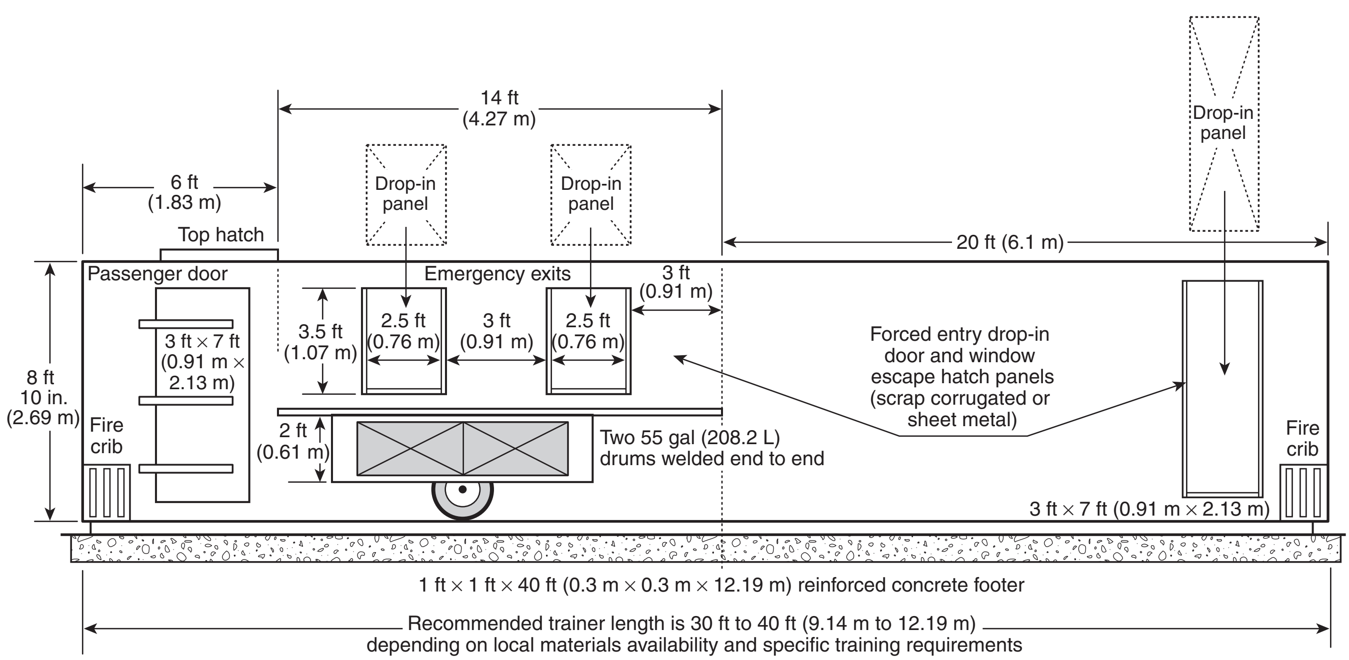

FIGURE 13.11.4(d) Aircraft Fire Suppression and Rescue Live Fire Training Mock-Up (over-wing egress side view).